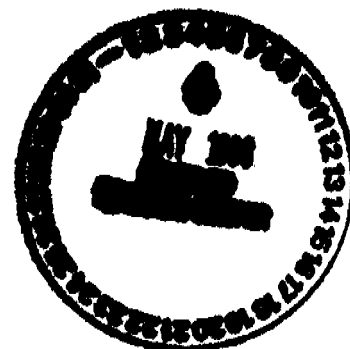


NOTICE

All drawings located at the end of the document.



**SAMPLING AND ANALYSIS PLAN
TO SUPPORT THE SOURCE REMOVAL AT
THE TRENCH T-1 SITE
IHSS 108**

Rocky Mountain Remediation Services, L.L.C.

**April 23, 1998
Revision 0**

ADMINISTRATIVE INFORMATION

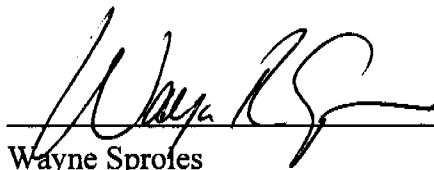
Site: Rocky Flats Environmental Technology Site (RFETS), Golden, Colorado

Project Name: Source Removal at Trench 1 - IHSS 108

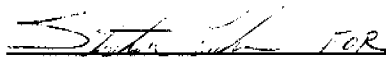
Date Prepared: April 23, 1998

Approvals

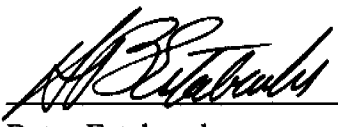
I have read and approved this Sampling and Analysis Plan with respect to the hazards, regulatory requirements and objectives of the project.


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ACRONYMS

| | |
|--------------------------------|--|
| ADM | Administrative Procedures Manual |
| ASD | Analytical Services Division |
| ASTM | American Society for Testing Materials |
| CCR | Colorado Code of Regulations |
| COC | Chain of Custody |
| CPM | Counts Per Minute |
| CRZ | Contamination Reduction Zone |
| CWTF | Consolidated Water Treatment Facility |
| DQO(s) | Data Quality Objectives |
| DTA | Differential Thermal Analysis |
| DU | Depleted Uranium |
| EPA | Environmental Protection Agency |
| EMD | Environmental Management Department |
| FID | Flame Ionization Detector |
| FIP | Field Implementation Plan |
| FIDLER | Field Instrument for the Detection of Low Energy Radiation |
| HCl | Hydrochloric Acid |
| HPGe | High Purity Germanium |
| HNO ₃ | Nitric Acid |
| H ₂ SO ₄ | Sulfuric Acid |
| IHSS | Individual Hazardous Substance Site |
| LDR(s) | Land Disposal Restrictions |
| LLW | Low-level Waste |
| MDA | Minimum Detectable Activity |
| NaOH | Sodium Hydroxide |
| NTS | Nevada Test Site |
| OVA | Organic Vapor Analyzer |
| PAM | Proposed Action Memorandum |
| PARCC | Precision, Accuracy, Representativeness, Completeness, and Comparability |
| PCE | Tetrachloroethene |
| ppm | Parts Per Million |
| QA | Quality Assurance |
| QC | Quality Control |
| QE | Quality Engineer |

(continued next page)

Acronyms Continued

| | |
|-----------------|---|
| RCRA | Resource Conservation and Recovery Act |
| REP | Radiological Engineering Procedure |
| RFCA | Rocky Flats Cleanup Agreement |
| RFETS | Rocky Flats Environmental Technology Site |
| RIN | Report Identification Number |
| RMRS | Rocky Mountain Remediation Services, L.L.C. |
| ROI | Radiological Operating Instruction |
| SAP | Sampling and Analysis Plan |
| SOPs | Standard Operating Procedures |
| SOW | Statement of Work |
| SWD | Soil and Water Database |
| T-1 | Trench-1 |
| TCE | Trichloroethene |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TGA | Thermogravimetric Analysis |
| VOA | Volatile Organic Analysis |
| VOCs | Volatile Organic Compounds |
| WAC | Waste Acceptance Criteria |
| WEMS | Waste Environmental System |
| yd ³ | Cubic Yard |

LIST OF STANDARD OPERATING PROCEDURES (SOPs)

IDENTIFICATION NUMBER:

PROCEDURE TITLE:

| | |
|--------------------|--|
| 5-21000-OPS-FO.03 | <i>General Equipment Decontamination</i> |
| 5-21000-OPS-FO.13 | <i>Containerization, Preserving, Handling and Shipping of Soil and Water Samples</i> |
| 2-G32-ER-ADM-08.02 | <i>Evaluation of ERM Data for Usability in Final Reports</i> |
| ROI 6.6 | <i>Operation of the Bicron FIDLER</i> |
| 4-S23-ROI-03.02 | <i>Radiological Requirements for Unrestricted Release</i> |
| 4-Q97-REP-1003 | <i>Radiological Evaluation for Unrestricted Release of Property/Waste</i> |

Note: ROI and RSP procedures are currently being reformatted to new Radiological Safety Practices (RSP) format. Use of RSP format will not require update to this plan.

1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) supports the accelerated Source Removal at the Trench 1 (T-1), Individual Hazardous Substance Site (IHSS) 108, at the Rocky Flats Environmental Technology Site (RFETS), located near Golden, Colorado. The T-1 source removal project is described in the Final Proposed Action Memorandum (PAM) for the Source Removal at Trench 1, IHSS 108 (RMRS, 1998a). This SAP is intended to provide guidance for collecting accurate and reproducible samples to support the decisions required by the project. Sampling activities will be conducted in accordance with the RMRS Quality Assurance Program Description (RMRS, 1996a).

Two SAPs will be used to support this source removal. A different SAP will be used by the Starmet team, the subcontracted team responsible for inerting and treating potential pyrophoric materials from T-1 (Starmet, 1998). This SAP, prepared by Rocky Mountain Remediation Services, L.L.C. (RMRS) was developed to support the characterization and disposition of materials that are not considered to be pyrophoric and are thus outside of the scope of the treatment subcontractor. This SAP addresses environmental media including excavated soils, incidental waters, and *in situ* natural soils. This SAP also includes the field screening and characterization of other waste streams generated or excavated during the remediation of T-1. The waste streams may include drums fragments which originally contained depleted uranium (DU) and lathe coolant, construction debris and trash, bulk liquids, sanitary waste, used personal protective equipment (PPE), and other materials.

Sampling and analytical testing activities associated with waste materials relinquished to the Starmet team for subsequent processing will be included in the Starmet SAP.

Site and ambient air monitoring will also be conducted; however, these activities will be addressed in the T-1 Health and Safety Plan and in enhancements to the Rocky Flats Ambient Air Management Plan.

Background

The T-1 site is located just northwest of the inner east gate, and about 40 feet south of the southeast corner of the Protected Area fence (Figure 1-1). The trench is approximately 200 feet long, 15 to 20 feet wide, and 10 feet deep. Historical documentation indicates DU metal chips (lathe and machine turnings) originating from Building 444 were packed with lathe coolant and buried in the west end and possibly the east end of T-1 in approximately 125 drums. The actual

number of drums in the trench is unknown. One hundred twenty-five drums have been documented in previous reports dating back to 1970; however, only 84 drums are accounted for in available waste inventories from 1959-1962. Ten drums of cemented cyanide and one drum of "still bottoms" (recovered waste solvents or evaporated lathe coolant sludge) are suspected to be buried in T-1. The drums and debris may also contain volatile organic compounds (VOCs).

Drums disposed of in the trench were reportedly double stacked end-on-end and covered with one to two feet of soil. No written documentation exists for the contents of the center and east end of the trench. However, interviews with former site workers indicate that the eastern two-thirds of the trench is likely to contain trash consisting of pallets, paper, and other debris such as empty or crushed drums. Summaries of the interviews are contained in the project files. Burial operations in the trench continued intermittently from November 1954 to December 1962.

Weed cutting activities conducted in October and November 1982 unearthed the upper portion of two drums not adequately covered with fill material. Samples of the liquids and sludges contained in these drums were collected for radiochemical analyses and yielded low levels of plutonium, and uranium activities indicative of enrichment.

Since discovery of the drums, site investigations have been conducted to evaluate the suspected area of impact and the potential contaminants. These investigations included additional soil and groundwater samples at locations surrounding the trench area, a soil gas survey, an electromagnetic and ground penetrating radar survey, a review of historical aerial photographs, employee interviews, and a detailed records search. Based on a review of the data, impacts of the T-1 contaminants are considered to be primarily confined to the soil within the trench boundaries. Additional information on the site background, investigation data, suspected radiological and chemical impacts, geology and hydrogeology have been collected and documented in the reports listed below:

- Historical Release Report for the Rocky Flats Plant (DOE, 1992);
- Phase II RFI/RI Report for Operable Unit No. 2 - 903 Pad, Mound, and East Trenches Area, Rocky Flats Environmental Technology Site (DOE, 1995a); and
- Draft Trenches and Mound Site Characterization Report, (RMRS, 1996b)
- Proposed Action Memorandum for the Source Removal at the Trench T-1 Site, IHSS 108 (RMRS, 1998a).

The goals of this accelerated action are to: remove all drummed wastes and debris, remove all contaminated soil exceeding Rocky Flats Cleanup Agreement (RFCA) (DOE, 1996) Tier I action levels for radionuclides, VOCs, and cyanide (if any), and disposition the soils, drummed waste and debris.

2.0 SAMPLING AND DATA QUALITY OBJECTIVES

Data needed to support the objectives of the T-1 source removal project were developed using criteria established in *Guidance for the Data Quality Objective Process*, EPA QA/G-4 (EPA, 1994). The data gaps, study boundaries, decisions, etc., are described in Sections 2 and 3 of this plan.

The primary objectives of this SAP are:

- To evaluate/verify that cleanup target levels for excavation specified in Table 3-1 of the PAM are met
- To evaluate whether excavated soils can be returned to the excavation
- To support off-site disposal of soil containing levels of radioactivity or VOCs in excess of Tier I Subsurface Soil Action Levels
- To support various waste classifications for off-site disposition of debris and secondary wastestreams
- To support onsite treatment of incidental waters (e.g., groundwater removed from the excavation)

Sections 2.1 and 2.2 discuss decisions based on RFCA action level comparisons. These include decisions to complete excavation activities and determinations of applicability to return excavated soils below the respective action levels to the trench. In addition to these evaluations, variability of the data set as a whole will also be evaluated based on guidance provided in EPA QA/G-4, *Guidance for the Data Quality Objectives Process* (EPA, 1994). Use of this guidance will allow the variance to be evaluated relative to the mean value of the sample results and its comparison with action levels (RFCA Tier I or Tier II). Using the sample results, QA/G-4 provides guidance to compute the required minimum number of samples necessary to make a

statistically valid decision. If the predicted number of samples is greater than the number actually taken, variance within the sample set would be considered "extreme" and more samples will be required. Conversely, if the number of samples predicted by QA/G-4 is less than or equal to the number specified in the sampling plan, variance would not be considered extreme, and the number of samples specified in the sampling would be considered adequate.

Logarithmic transformations will be performed as necessary for those contaminants that are logarithmically distributed (e.g., radionuclides) based on site historical data.

2.1 DQOs TO EVALUATE CONDITIONS AT THE EXCAVATION BOUNDARIES

To evaluate/verify that cleanup target levels for excavation specified in Table 3-1 of the PAM are met, soil samples will be collected at the excavation boundary. These samples will also be used to document the conditions remaining at the excavation boundary for a future RFETS Site-wide risk assessment and to supply data for evaluating any future impacts on groundwater.

In accordance with the PAM, soil samples will be collected along the base and sides of the excavation and analyzed for the following parameters, as appropriate:

- Radioisotopes
- Volatile Organic Compounds
- Cyanide

2.1.1 Radioisotopes

DU and radiologically contaminated debris are expected to be the largest waste streams disposed of in T-1. The PAM states that 125, 30-gallon and 55-gallon steel drums containing 10,000-20,000 kg of DU chips and turnings, and miscellaneous debris were believed to have been disposed in T-1. It is anticipated that because of the large number of drums and miscellaneous debris (with a reasonable likelihood of radiological contamination), that radiological contamination will not be confined to easily identifiable sectors within the trench. As a result, the sampling strategy will be to collect a statistically significant sample population across a grid pattern established over the entire trench/excavation boundary.

As stated in RFCA, in order to account for total dose from multiple radionuclides, the sum-of-ratios method must be applied to evaluate potential dose. If radiological results from the same sample indicate a sum-of-ratios value > 1 , using Tier I Subsurface Soil Action Levels, the area represented by that sample will be removed, and the area re-sampled in approximately the same

(x,y or vertical) position. This process will be repeated until the action levels (using sum-of-ratios) or limiting conditions stated in the PAM are met. These constraints state that the excavation will be limited to the highly weathered bedrock below the alluvial/bedrock contact. This highly weathered bedrock is expected to extend one to three feet below the alluvial/bedrock contact.

An example of the sum-of-ratio equation, using the Tier I Subsurface Soil Action Levels (open space scenario), is given below:

$$\frac{C_{Am-241}}{215 \text{ pCi/g}} + \frac{C_{Pu-239/240}}{1429 \text{ pCi/g}} + \frac{C_{U-234}}{1738 \text{ pCi/g}} + \frac{C_{U-235}}{135 \text{ pCi/g}} + \frac{C_{U-238}}{586 \text{ pCi/g}} \leq 1$$

Where C is the measured concentration of the specific isotope in pCi/g. Note that the less than or equal to symbol “≤” on the right side of the equation would be indicative of a sum-of -ratio value less than the respective action level.

A High Purity Germanium (HPGe) detector equipped gamma spectroscopy system will be set up in a field trailer (T900C) and will be used to evaluate the radioisotope concentrations in the soil and excavated materials. The subcontractor will provide a system and software that has been verified, and approved in accordance with the Kaiser Hill Analytical Services Division (ASD) SOW, *Determination of Radionuclides by Gamma Spectroscopy, Module RC03-A*, prior to use. The RFCA isotopes that can be readily detected using an HPGe equipped gamma spectroscopy system are americium-241, uranium-235 and uranium-238. The Minimum Detectable Activities (MDAs) for these isotopes will be established at approximately 1/10 the Tier II Subsurface Soil Action Levels. This will enable effective evaluation of the sum-of-ratios values. Conservative assumptions will be used to establish concentrations of the other RFCA isotopes (uranium-234 and plutonium-239/240) for input into the sum-of ratios equation. Appendix 1 provides the assumptions used in determining plutonium concentrations from americium-241 activities using gamma spectroscopy.

Gamma spectroscopy is not an effective method for determining uranium-234 activity due to the low incidence of production of gamma decays from this isotope. The natural background activity ratio between U-234 and U-238 will be assumed for soils at the excavation boundary. The *Background Geochemical Characterization Report* lists the mean background activity from 62 samples of the Rocky Flats Alluvium as 0.64 pCi/g for both uranium-234 and uranium-238 (EG&G, 1993). Therefore, the activity ratio of U-234 to U-238 is 1:1. This assumption is appropriate for conditions involving natural uranium (e.g., relatively clean excavation bottom

soils) but is conservative for DU contaminated materials as much of the uranium-234 is separated along with uranium-235 during the enrichment process, thereby creating DU. In the unlikely event that enriched uranium is detected, uranium-234 activities will be evaluated by radiological engineering.

In establishing the grid spacing for radionuclides the following statistical evaluation was performed.

DECISIONS:

If a sample yields radioisotope results that exceed unity (i.e., 1) when input into the sum-of-ratios equation (using RFCA action levels for the radioisotopes in the denominators), then the soil volume associated with the sample will be removed from the trench until further sampling yields results less than unity.

If all final samples yield radioisotope results less than unity (sum-of-ratios) as described above, then the excavation is considered complete (for radionuclides), and contamination removal is also complete.

ERROR LIMITS:

The design for confirmation sampling accounts for both quantification of probable sampling error (e.g., in missing remnant contamination in the trench after excavation concludes) and practical implementation in the field. The floor and sidewall sampling plan is implementable with any trench length, to any floor depth above bedrock, and with a trench width varying between 10 and 25 feet. Further, the sampling points within the grid layout allow for straightforward remediation of grid cells associated with samples revealing remnant contamination.

The grid layout, in its entirety, is necessary for radionuclide sampling based on the presumed pervasive presence of DU throughout the trench volume.

FLOOR SAMPLING:

A rectangular grid placed symmetrically along the center longitudinal axis of the excavation floor provides a statistical confidence in detecting any remaining "hot-spots": 90% confidence for circular spots >19' in diameter and 80% confidence for spots >17'. Derivation of statistical confidence in the sampling plan is based on Gilbert (1987). In particular, the central band running the length of the excavation – between the sampling points – is the area of the trench floor with predictable confidence. The sample spacing and its relative configuration on the

excavation floor was designed not only to provide some statistical confidence, but also to provide a practical means of implementation in the field in spite of varying (actual) lengths and widths of the final excavation. Error tolerance is typically acceptable at confidences greater than 80% as an environmental industry standard (e.g., SW-846, Chapter 10). It should be noted that confidences will actually be higher than those calculated because samples will not be taken as grabs or discrete points in the center of the grid cells (as assumed by the statistical model) but rather as composites within a centrally located 4'x4' area within the cell (the approximate "swath" of the excavator bucket used to collect the sample).

In an effort to account for within grid cell (intracell) variability, the trench will be further divided into three general areas (east, west and central areas). Within each area one grid cell will be sampled in three locations (See Figure 3-1). This will allow for a partial evaluation of variability within individual grid cells.

The number of samples and associated errors are listed in Table 2-1, and depicted graphically in Figure 3-1. As indicated by Figure 3-1, if any sample result exceeds a RFCA action level, the entire area represented by the sample shall be excavated and resampled in approximately the same location (x,y). Excavation will be repeated for the volume of interest until the corresponding sample results are below action levels, or the limiting conditions established in the PAM are met.

SIDEWALL SAMPLING

Projected sample quantities and locations for the sidewalls are also given in Table 2-1 and Figure 3-1, respectively. Samples will be taken in the longitudinal direction at the same spacing as shown for the excavation floor (20' spacing). Vertically, the samples will be taken near the midpoint of the wall height (~5' above the floor).

A judgemental and systematic sample pattern is recommended in contrast to a purely systematic grid pattern for the following reasons:

- Well-documented process knowledge of the trench's lateral constraints, such as aerial photographs
- Neither VOCs nor radionuclides are present at elevated levels within monitoring wells immediately surrounding or downgradient from the T-1 location

**TABLE 2-1 STATISTICAL PARAMETERS USED TO DETERMINE
EXCAVATION BOUNDARY SAMPLE APPROACH**

CONFIRMATION SAMPLES -- CONFIDENCE IN DETECTING HOT SPOTS

{RECTANGULAR GRID; CIRCULAR CONTAMINATION GEOMETRY ASSUMED}

| | G (grid space, ft) | "Hot Spot" diam (ft) | L | S | L/G | # of samples ¹ | # of samples ² | Beta error |
|---|---|-------------------------|-----|----|------|------------------------------|------------------------------|------------|
| TRENCH FLOOR | 10x20 | 19.2 | 9.6 | 1 | 0.96 | 20 | 26 | 10% |
| | 10x20 | 17.4 | 8.7 | 1 | 0.87 | 20 | 26 | 20% |
| additional samples within cells to evaluate intracell variability | | | | | | 6 | 6 | 5% |
| | <div style="border: 1px solid black; padding: 2px; display: inline-block;">Linear spacing</div> | | | | | | | |
| TRENCH WALL (Long, North) | 10 | NA | NA | NA | NA | 10 | 14 | NA |
| TRENCH WALL (Long, South) | 10 | NA | NA | NA | NA | 10 | 14 | NA |
| TRENCH WALL (Short, West) | 10 | NA | NA | NA | NA | 1 | 1 | NA |
| TRENCH WALL (Short, East) | 10 | NA | NA | NA | NA | 1 | 1 | NA |
| SAMPLE TOTALS | | | | | | 48 | 62 | |

S = (length of short axis)/(length long axis)

L = 1/2 length of long axis of ellipse

calculations based on Gilbert, 1987, Ch. 10; see Figure 3-1 for a schematic

NOTE: based on the sampling technique, i.e., use of a large excavation bucket/backhoe,
resolution of the grid spacing can be no better than 4 feet

¹assuming a trench geometry of D = 10', W=20', and L=200'

²assuming a trench geometry of D = 10', W=20', and L=250'

filename: T1cnfrm4.xls

- The relatively low hydraulic gradient (~ 0.02) at the T-1 location. Lateral migration of contamination past the trench boundaries is not suspected to be significant, as the primary pathway direction should be vertical, due to the relatively high specific gravities of the contaminants of concern
- Sample locations are chosen for their unique value and representation (worst-case lateral migration of contaminants) rather than for drawing inferences about a wider population (across the entire sidewall areas)

To account for any potential lateral migration, sample locations are designated at the vertical midpoints of the sidewalls ($\sim 5'$ above the floor), with the same longitudinal spacing as the floor ($20'$). This sampling geometry allows determination of contaminant migration in all cardinal directions. Excavation will proceed to native soils which will provide further confidence that radiological contaminants within the trench are successfully removed. In addition, any visual characteristics that suggest contamination, such as staining or discoloration of the native soil, will be excavated or sampled and excavated, as appropriate. Areas with sample results greater than action levels will be remediated in the same way as described for the excavation floor.

2.1.2 Volatile Organic Compounds

As stated in the PAM, one drum containing “still bottoms” may have been placed in T-1. As a result, the PAM has included the VOCs tetrachlorethene (PCE) and trichloroethene (TCE) as potential contaminants of concern. Soil borings located outside of the trench have not indicated significant levels of VOCs. Therefore, VOC contamination, if present, is expected to be confined to localized areas surrounding drums or drum carcasses which contain(ed) “still bottoms”, i.e., residue from the recovery (redistillation) of solvents or oils. It is anticipated that identification of “still bottom” waste, if present, will be a relatively simple task, using visual characteristics, and the organic vapor analyzers (OVAs) operated by the industrial hygiene personnel during the excavation. If encountered, drums containing still bottoms will be sampled for VOCs and other constituents under the Starmet SAP. In addition, per the Starmet SAP a significant number of drums containing DU waste will be sampled for VOCs and other constituents. If results of the sampling indicate the presence of VOCs above the action levels specified in the PAM, sampling of the excavation bottom in the vicinity of where the still bottoms or other waste were located will be conducted.

If VOCs are detected in drummed waste above the PAM action levels, the area surrounding the drum will be sampled using the systematic approach described below. These samples will be

analyzed according to the U.S. Environmental Protection Agency's (EPA) SW-846 Method 8260A for total VOCs. These samples are considered "critical samples" for completeness calculations. If VOC results exceed the levels specified in the PAM the area represented by that sample will be removed, and the area re-sampled in approximately the same (x,y or vertical for sidewall) position. This process will be repeated until the action levels or limiting conditions stated in the PAM are met.

The VOCs are presumed to be relatively isolated (directly associated with a drum(s) of still bottoms within the trench) in contrast to the widespread nature of radioisotopes within the trench. As a result, only an encompassing portion of the established overall grid used for radioisotopes will be utilized for sampling VOCs. Points in the grid cell centers will be sampled for VOCs that immediately encompass (i.e., that are closest to) the point location(s) where still bottoms or other probable VOC contaminated materials are encountered. This approach will require the collection of approximately five (5) VOC samples (one from the cell which originally contained the material and four samples from cells bounding the original cell). This approach will yield the same confidences associated with radionuclide sampling, but will optimize the total number of samples by using process knowledge (e.g., identification of still bottom drums within the trench). In the event that no VOCs are detected during the project (e.g., field screening, still bottoms, or DU sampling), then at least two VOC samples will still be collected from the excavation bottom. An attempt will be made to bias these samples to locales within the trench that may indicate greater likelihood of VOC contamination. It is recognized that this identification will be difficult based on the lack of other objective evidence, however professional judgement will be used.

2.1.3 Cyanide

As stated in the PAM, ten drums containing cemented cyanide waste may have been placed in T-1. As a result, the PAM has included cyanide as a potential contaminant of concern. Because of the nature of the cemented waste, and the relatively high Tier I Subsurface Soil Action Level for cyanide (154,000 mg/kg), concentrations of cyanide in soil in excess of the Tier I action levels are improbable. Therefore, soil sampling for cyanide will be confined to localized areas surrounding drums or drum carcasses which contain cemented cyanide waste. Identification of cemented cyanide waste, if present, should be a relatively simple task, using visual characteristics. Drums containing cemented cyanide waste will be sampled for cyanide and other constituents under the Subcontractor supplied SAP. If results of sampling indicate the presence of cyanide above the action levels specified in the PAM, sampling of the excavation bottom in the vicinity of where the cemented cyanides were located will be conducted. If cemented cyanide drums are not encountered or the concentrations of cyanide in encountered drums are less than

the concentration established in the PAM, sampling for cyanides on the excavation bottom will not be conducted.

If cyanides are detected in drummed waste above the PAM action levels, the areas surrounding the drums will be sampled using the systematic grid described below. These samples will be analyzed in accordance with SW-846 Method 9010A for total cyanide. If cemented cyanides are encountered in the trench, these samples will be considered "critical samples" for completeness calculations. If sample results are in excess of the Tier I Subsurface Soil Action Level for cyanide, the area represented by that sample will be removed, and the area re-sampled in approximately the same (x,y or vertical for sidewall) position. This process will be repeated until the action level or limiting conditions stated in the PAM are met.

Cyanides within T-1 are presumed to be relatively isolated (directly associated with drums of cemented cyanide) in contrast to the widespread nature of radioisotopes within the trench. As a result, only an encompassing portion of the established overall grid used for radioisotopes will be used in sampling for cyanide. Points in the grid cell centers will be sampled for cyanide that immediately surround the point location(s) where cemented wastes containing cyanides are encountered within the trench. This approach will require the collection of approximately five (5) cyanide samples (one from the cell which originally contained the material and four samples from cells bounding the original cell). This approach will yield the same confidences associated with radionuclide sampling, but will optimize the total number of samples by using process knowledge (e.g., identification of cemented cyanide waste within the trench).

2.2 DQOs TO EVALUATE RETURN OF SOIL TO THE EXCAVATION OR OTHER ONSITE OPTIONS

Samples will be collected to characterize stockpiled soils originating from the excavation. Excavated soil will be visually observed and field screened as it is removed from the trench. Several stockpiles/containerization options are anticipated to be used for segregation based on the results of the visual observations and field screening. Soil with no visual evidence of metallic DU chips/turnings will be segregated into one of the categories described in Table 2-2.

Soil removed from the excavation and placed into one of the soil stockpiles described above will be evaluated with respect to the Tier I and Tier II Subsurface Soil Action Levels for radionuclides prior to determining final disposition. Both stockpiles will be assumed to be free of chemicals (including VOCs) based on the field screening described above, however three VOC samples will be collected randomly from Stockpile 1 for verification purposes (See Section 2.2.1).

TABLE 2-2 APPROACH TO SEGREGATION OF T-1 OVERBURDEN SOIL

| Material | Initial Screening Methods | Results | Decision/Segregation Category |
|---|-------------------------------------|---|--|
| Overburden soil (low potential for pyrophoricity) | Visual Observation FIDLER OVA | No significant staining FIDLER < 5,000 CPM OVA < 25 ppm above background | Segregate to Stockpile 1 |
| | | No significant staining FIDLER ≥ 5,000 but ≤ 10,000 CPM OVA < 25 ppm above background | Segregate to Stockpile 2 |
| | | No significant staining FIDLER > 10,000 CPM OVA < 25 ppm above background | Containerize for Offsite Disposition (evaluate under Section 2.3) |
| | | Significant staining or OVA ≥ 25 ppm above background | Containerize. Future onsite treatment for VOCs possible. |

2.2.1 Soils Containing Low Levels of Radioactivity

Stockpile 1 will be used to stage soil containing low levels of radioactivity. All soil placed in Stockpile 1 will contain soil that has been determined to be less than 5,000 counts per minute (CPM) on a Field Instrument for the Detection of Low Energy Radiation (FIDLER). This value corresponds to approximately three times background in the T-1 area. This FIDLER screening value was obtained using empirical data from previous environmental restoration activities (RMRS, 1996c). These activities showed that below this screening level, there is little potential of exceeding RFCA Tier II Subsurface Soil Action Levels for radionuclides, and no potential for exceeding Tier I (ibid.), therefore soil would be acceptable for return to the excavation. However, other than the empirical evidence, there is no direct correlation between the FIDLER response and the RFCA action levels.

The PAM states that no further radiological evaluation of this stockpile is required (RMRS, 1998a). However, as a final confirmation to support the rationale described above, three composite samples will be collected randomly from Stockpile 1. Each sample will be made up of 4 subsamples collected from the stockpile. These samples will be analyzed by gamma spectroscopy, and the values will then be input into the sum-of-ratio equation and compared with the RFCA Subsurface Soil Action Levels.

In addition to the three radiological samples described above, three VOC confirmation samples will be collected from Stockpile 1. These samples will be collected as grabs, randomly around

the stockpile. These values will then be evaluated with respect to the RFCA Tier I Subsurface Soil Action Levels for VOCs.

2.2.2 Soils Containing Moderate Levels of Radioactivity

Soil placed in Stockpile 2 will contain soil between 5,000 and 10,000 CPM on a FIDLER. It is possible that FIDLER values below 10,000 CPM will have radionuclide soil concentrations below the RFCA Tier I Subsurface Soil Action Levels (using a sum-of-ratio evaluation). However, this assumption requires analytical data to support the determination. If analytical results indicate that the soil is below the Tier I action levels, then the soil may be returned to T-1, under the conditions stipulated in the PAM.

Grab samples will be collected from this soil to evaluate the isotopic concentrations with respect to the RFCA action levels specified in the PAM. Samples will be evaluated by HPGe gamma spectroscopy analysis. The MDAs for the isotopes will be established at approximately 1/10 (or less) the Tier II Subsurface Soil Action Levels. This will enable effective evaluation of the sum-of-ratios values. If radionuclides concentrations are in excess of RFCA action levels, offsite disposal options will be pursued. Additional offsite disposal DQOs are described in Section 2.3.

The sampling strategy is described below. Because soil will not be thoroughly mixed prior to placement in the stockpile, random soil sampling will be performed between excavation and placement of the soil in the stockpiles or waste containers (as appropriate). This approach will address potential contaminant heterogeneities within the soil due to contaminant heterogeneities within the trench. Further, true random sampling would be difficult to implement after stockpile formation due to safety concerns associated with personnel movement on the stockpile.

As no background data is available for the T-1 soils (in situ), a minimum number of samples is stipulated based on initial stockpile estimates. Sample number will be reevaluated after the minimum number of samples is taken to ensure that an adequate confidence is achieved (after EPA G-4). Preliminary volumetric estimates of the total soils from the excavation are ~1700 yds³; of that, ~50% is estimated to exceed 5,000 cpm on the FIDLER, which necessitates isotopic characterization based on the PAM. As shown in Table 2-3, a minimum of 34 samples are proposed for definition of the sample distribution characteristics and an initial evaluation of whether enough samples have been acquired for confident disposition of the waste stream (relative to RFCA action levels). With the soil volume estimates stated above, 34 samples correspond to, on average, 1 sample per ~25 yds³ of soil (1 sample per 24 yds³ for soil placed into stockpiles and 1 sample per 25.2 yds³ for soil placed into containers); 25 yds³ also allows

easy conversion to the numbers of buckets (front end loader buckets) or waste containers per sample (8 buckets and 7 waste containers, respectively). The random sampling scheme is given in Table 2-3.

PROCESS SAMPLING

The sampling plan is designed to ensure random samples by taking composite samples from the waste stream, either from the front-end loader's bucket, the isolated pile directly (immediately after dumping), or from waste containers. The random sample sequence is given in Table 2-3. Table 2-3 is specifically designed for two soil waste streams, segregated as soils >10,000 cpm (See Section 2.3) and soils ranging from 5,000 cpm to 10,000 cpm (initial FIDLER readings). Samples from either category can be acquired relative to bucket volumes or from waste containers. However, sampling acquisition should be consistent from start to finish for each unique waste stream. Advantages of process sampling vs. stockpile sampling are as follows:

- Avoid logistical problems of sampling odd-geometry waste piles
- Random sampling is easier to implement in process
- Samples will represent chronology of excavation, and thus process knowledge from one end of the trench to the other
- Can take fewer samples at first, evaluate the statistics (i.e., the number of samples needed based on EPA/G-4), and take more samples later, if necessary
- Will result in a more level sample load for the gamma spectroscopy laboratory

Prior to making decisions based on the data, the statistical confidence in the data will be established. Based on historical RFETS environmental data, the most likely results are either log normal or normally distributed data. Results from the first round of samples will be evaluated statistically (after EPA G-4 and G-9 methodologies, as applicable) and compared to RFCA action levels and offsite facility WACs (as appropriate) to determine if enough samples were taken.

TABLE 2-3 RADIOLOGICAL SAMPLING FREQUENCY FOR SOIL > 5,000 CPM

| SOIL STOCKPILE SAMPLING PLAN (>5000 cpm) | | | | | | | | |
|--|--|---|---------------------|---|---|-------------------------------------|--|--|
| % of total ^A soil | stockpile volume (yd ³) | volume/ sample ratio (yd ³) ^B | # of samples | sequential sampling event (# of samples) | random # in 8- bucket sequence | sequential # of total buckets | random # in 7- container sequence | sequential # of total containers |
| 10% | 170 | 50 | 4 | 1 | 6 | 6 | 7 | 7 |
| 10% | 170 | 40 | 5 | 2 | 7 | 15 | 4 | 11 |
| 10% | 170 | 30 | 6 | 3 | 4 | 20 | 2 | 16 |
| 10% | 170 | 25 | 7 | 4 | 5 | 29 | 3 | 24 |
| 10% | 170 | 20 | 9 | 5 | 8 | 40 | 6 | 34 |
| 10% | 170 | 10 | 17 | 6 | 2 | 42 | 2 | 37 |
| | | | | 7 | 5 | 53 | 1 | 43 |
| 20% | 340 | 50 | 7 | 8 | 6 | 62 | 7 | 56 |
| 20% | 340 | 40 | 9 | 9 | 6 | 70 | 3 | 59 |
| 20% | 340 | 30 | 12 | 10 | 8 | 80 | 7 | 70 |
| 20% | 340 | 25 | 14 | 11 | 2 | 82 | 4 | 74 |
| 20% | 340 | 20 | 17 | 12 | 5 | 93 | 1 | 78 |
| 20% | 340 | 10 | 34 | 13 | 8 | 104 | 4 | 88 |
| | | | | 14 | 6 | 110 | 2 | 93 |
| 30% | 510 | 50 | 11 | 15 | 2 | 114 | 1 | 99 |
| 30% | 510 | 40 | 13 | 16 | 2 | 122 | 2 | 107 |
| 30% | 510 | 30 | 17 | 17 | 5 | 133 | 3 | 115 |
| 30% | 510 | 25 | 21 | 18 | 7 | 143 | 2 | 121 |
| 30% | 510 | 20 | 26 | 19 | 6 | 150 | 7 | 133 |
| 30% | 510 | 10 | 51 | 20 | 5 | 157 | 6 | 139 |
| | | | | 21 | 3 | 163 | 3 | 143 |
| 40% | 680 | 50 | 14 | 22 | 2 | 170 | 7 | 154 |
| 40% | 680 | 40 | 17 | 23 | 7 | 183 | 6 | 160 |
| 40% | 680 | 30 | 23 | 24 | 4 | 188 | 4 | 165 |
| 40% | 680 | 25 | 28 | 25 | 2 | 194 | 1 | 169 |
| 40% | 680 | 20 | 34 | 26 | 5 | 205 | 2 | 177 |
| 40% | 680 | 10 | 68 | 27 | 1 | 209 | 2 | 184 |
| | | | | 28 | 5 | 221 | 6 | 195 |
| 50% | 850 | 50 | 17 | 29 | 2 | 226 | 6 | 202 |
| 50% | 850 | 40 | 22 | 30 | 4 | 236 | 6 | 209 |
| 50% | 850 | 30 | 29 | 31 | 2 | 242 | 1 | 211 |
| 50% | 850 | 25 | 34 | 32 | 2 | 250 | 2 | 219 |
| 50% | 850 | 20 | 43 | 33 | 6 | 262 | 7 | 231 |
| 50% | 850 | 10 | 85 | 34 | 7 | 271 | 1 | 232 |
| | | | | 35 | 3 | 275 | 1 | 239 |
| | | | | 36 | 7 | 287 | 3 | 248 |
| | | | | 37 | 1 | 289 | 1 | 253 |
| | | | | 38 | 5 | 301 | 4 | 263 |
| | | | | 39 | 6 | 310 | 7 | 273 |
| | | | | 40 | 6 | 318 | 3 | 276 |
| ^A estimated @ ~1700 yd ³ | | | | | | | | |
| Capacities: | | | | | | | | |
| front-end loader = | | | 3 yd ³ | | | | | |
| soil containers = | | | 3.6 yd ³ | | | | | |
| starmet containers = | | | 1.6 yd ³ | | | | | |
| ^B approximate | | | | | | | | |
| | | | | | | stckpil4.xls | | |

2.2.3 Soils with a Significant VOC Contamination Potential

If soil is encountered where field screening methods indicate a likelihood of significant VOC contamination (e.g., OVA readings ≥ 25 ppm above general area background), this material will be containerized for subsequent evaluation. The OVA measurement will be made with a flame ionization detector (FID), which is not expected to be influenced by diesel exhaust within the tent structure. Soil within this category is expected to be associated with a drum(s) containing still bottoms and is not anticipated to be a major waste volume generated during the T-1 project. Offsite treatment capacity is currently not available for soil with significant VOC contamination (e.g., in excess of RFCA and RCRA LDR treatment standards (6 CCR1007-3, Section 268.40)) which is also radioactive. In accordance with the PAM, soil in this category is expected to be stored onsite pending availability of future offsite treatment or onsite processing (e.g., thermal desorption which has been successfully performed on three previous RFETS source removals).

To assist in this evaluation, each waste container (3.6 yd³ capacity) filled with VOC contaminated material will be sampled for both radionuclides (using HPGe gamma spectroscopy) and VOCs (using SW846-8260A). If more than 10 waste containers are filled/sampled a statistical evaluation may be performed, and the sampling frequency may be reduced. If performed, a summary of this evaluation will be included in the project Closeout Report.

2.3 DQOs TO SUPPORT EVALUATION OF SOIL DESTINED FOR OFFSITE DISPOSAL

Samples will be collected to support off-site disposal of soil containing levels of radioactivity in excess of Tier I Subsurface Soil Action Levels. The data quality objective for excavated soil contaminated with radionuclides in excess of Tier I Subsurface Soil Action Levels will be to collect data which supports a complete evaluation of the waste with respect to the receiving facilities WAC. It is anticipated that the disposal facilities include Envirocare of Utah and the Nevada Test Site (NTS). Radioactive soil included in this subsection is expected to be derived from one of three wastestreams:

- Soil that was stockpiled during excavation activities, which after results of initial isotopic characterization is determined to be in excess of Tier I Subsurface Soil Action Levels and as a result cannot be returned to the excavation
- Soil with FIDLER readings in excess of 10,000 CPM which was subsequently containerized for disposition by RMRS

- Soil containing what appears to be oxidized DU chips or turnings (not expected to be pyrophoric), that has been placed directly into containers during the excavation activities for disposition by RMRS (note: this wastestream is expected to exhibit FIDLER readings in excess of 10,000 CPM)

Table 2-4 further describes these three wastestreams. It should be noted that Starmet may require soils to supplement the overpack of pyrophoric materials from T-1. Soils described in this section may be given to Starmet as a form of waste minimization. If so, soil turned over to Starmet will not require characterization under this SAP.

TABLE 2-4 T-1 SOIL DESTINED FOR OFFSITE DISPOSAL

| Material | Initial Screening Methods | Results | Decision |
|---|--|--|---|
| Overburden soil (low potential for pyrophoricity) | Sampled as part of Section 2.2 above | In excess of Tier I sum-of-ratio for radionuclides | RMRS offsite disposition (sample) or Give to Starmet for Overpack material |
| Overburden soil (low potential for pyrophoricity) | Visual Observation FIDLER OVA | No significant staining FIDLER > 10,000 CPM OVA < 25 ppm above background | RMRS offsite disposition (sample) or Give to Starmet for Overpack material |
| DU oxide contaminated soil | Visual Observation FIDLER OVA Pyrophoricity | FIDLER > 10,000 CPM (probable) OVA < 25 ppm above background Pyrophoricity is negative | RMRS offsite disposition (sample, including for pyrophoricity), or Give to Starmet for Overpack material |

2.3.1 Pyrophoricity Evaluation

If “oxidized DU” is packaged for RMRS disposal (in lieu of treatment by Starmet), this material will be sampled/evaluated for pyrophoricity. Samples will be collected in a biased manner to support this determination. Emphasis will be to collect samples which maximize the mass of “oxidized material” and minimize the mass of commingled soil. Using this rationale, if material containing the greatest ratio of what appears to be oxidized DU to soil is non-pyrophoric, all other soil dispositioned by RMRS with the same “oxidized DU” will be considered non-pyrophoric. Indications of “oxidation” include the DU no longer containing a metallic luster and having the characteristic of a yellow or blackish coating indicative of oxidation. The analysis used for the pyrophoricity determination will be *Analysis of Residue by Differential Thermal Analysis (DTA)*, Rocky Flats Laboratory Test Procedure L-4177-A, performed in the Rocky Flats 559 Laboratory.

Pyrophoric materials exhibit exothermic reactions during rapid oxidation. However, if the tested material is contaminated with a strong oxidizer (e.g., nitrates) false positive results may be indicated. Some of the machining oils used at Rocky Flats may have contained nitrites. If these components of the machining oils have degraded to nitrates an exothermic response may be indicated using the DTA analysis. (A potential false positive). At the discretion of the project manager, additional Rocky Flats expertise may be utilized to determine if the "positive" result is in fact due to pyrophoricity or another factor. Several tests may be utilized to assist in this determination, including:

- Analysis of Plutonium Oxide for Residual Pyrophoric Metal Fines (Thermogravimetric Analysis (TGA)), L-4135-G
- Infrared Analysis, L4204-A
- Various microscopic analyses
- Test N.2: Test Methods for Pyrophoric Solids (United Nations Manual of Tests and Criteria, Second Edition)

If materials that appear to be "oxidized DU" are determined to be pyrophoric, all material with visible DU will be considered pyrophoric.

Pyrophoricity testing will be performed on an as needed basis. If oxidized DU is encountered and is planned for RMRS disposition, a minimum of three samples will be collected to characterize the material. However, the number of samples may be increased at the discretion of the field supervisor, project manager, waste or sample coordinator.

2.3.2 Radiological Evaluation

Soils destined for offsite disposal will be evaluated for radionuclides as described in Section 2.2.2.

2.3.2 Chemical and Geotechnical Evaluation

Radioactive soil that is determined to not contain pyrophoric materials will be tested to facilitate other offsite disposal criteria. In general, the analytical suite required for mixed or low level radioactive waste disposal at the Envirocare facility is sufficient to meet the analytical

requirements of the NTS WAC or other facilities. Table 3-2 lists the tests required to meet the offsite facility WAC. Note that Table 3-2 includes geotechnical samples which are a required part of the Envirocare WAC. Geotechnical samples may be biased to collect the samples from soil that exhibits lower levels radioactivity, as long as the general soil characteristics are similar.

Sampling frequency for offsite WAC:

At least three (3) samples for chemical and geotechnical analyses will be taken randomly for evaluation of the wastestream with respect to offsite facility WACs. Consistent with EPA SW-846 (Chapter 10, *Sampling Methods*), for the purpose of evaluating solid wastes, the 90% upper confidence limit will be compared against the action levels of interest for decision making (i.e., determination of waste as nonhazardous or hazardous).

DECISIONS AND ERROR LIMITS

If the sample quantities are adequate based on variances and mean values of the sample results (specifically EPA G-4 or Gilbert, 1987), sampling is complete; otherwise collect the newly required minimum number of samples for comparison with the WAC. If the 90% upper confidence limit of the wastestream exceeds the appropriate WAC, the wastestream is designated as exceeding appropriate waste acceptance criteria and dispositioned for later treatment or disposal; otherwise, the wastestream (or stockpile, in total) is designated as acceptable for direct offsite disposal.

2.4 DQOs TO SUPPORT EVALUATION OF DEBRIS AND SECONDARY WASTESTREAMS

Samples will be collected to support various waste classifications for off-site shipment of debris and secondary wastestreams. The data quality objective for excavated debris and secondary waste will be to collect data to support an evaluation of the waste with respect to the WAC of the appropriate treatment, storage or disposal facilities. The disposal facilities include Envirocare and NTS. It is anticipated that the debris removed from the trench may include items such as scrap metal, wood, plastics, rubber, graphite, concrete, and general construction type materials. Final disposition of these wastes will depend on the characterization results and disposal options available at the time. The proposed disposal facilities have no capabilities to accept pyrophoric materials.

Testing non-granular, non-homogeneous materials such as debris for pyrophoricity is not practical, and relevant test methods are not known to exist. In lieu of this, several steps will be taken to ensure that debris removed from T-1 is not pyrophoric. These include:

- All debris removed from the trench will be visually verified to be free of metal (DU) turnings and chips
- Debris containing visual evidence of turnings or chips will be cleaned in such a way as to remove the chips and turnings (e.g., brushing turnings from debris)
- Debris which cannot be cleaned of the turnings/chips will be turned over to Starmet for treatment with other potentially pyrophoric materials

Debris that is determined to not contain pyrophoric materials will be tested to facilitate offsite disposal. In general, the analytical suite required for mixed (both hazardous and radioactive) or low level radioactive waste (LLW) disposal at the Envirocare facility is sufficient to meet the disposal requirements of the NTS WAC. Therefore, because disposition will depend on the results of the characterization, the comprehensive analytical suite required by Envirocare will be used to evaluate these wastes. The Envirocare WAC is contained in the facilities Customer Information Manual (Envirocare, 1996). The WAC requires that all chemical analysis be conducted at a Utah Department of Health, Division of Laboratory Services, certified laboratory (Note: this is not required for radiochemical analyses). Table 3-3 lists the analytical parameters necessary to evaluate the T-1 debris with respect to the WAC.

Radionuclide Evaluation:

In general, the same rationale and logic applied to soil waste sampling is applied to debris sampling, with the exception that no field screening will be used to segregate the debris (between nonradioactive and potentially radioactive streams). At least three (3) samples shall be taken per generic category of debris identified in the waste containers following excavation. The generic categories of debris, based on previous experience at the RFETS, are given below:

- wood
- plastic
- metal
- concrete/aggregate

This approach, together with random sampling, will address potential contaminant heterogeneities within the debris wastestreams. Furthermore, sampling of each generic debris type will allow weighted averaging of the waste stream, i.e., it will address the various types of debris without physically separating the debris. Weighted averaging will increase in importance when radionuclide activities differ between debris type. When debris types exhibit similar

radioisotopic levels, the importance of weighted averages will decrease. Sampling is expected to take place after each waste container is filled to ensure continuous sampling as the excavation progresses (vs. one major sampling event after conclusion of the project).

As no background data is available for the T-1 debris, the minimum number of samples stipulated in this section will be reevaluated after the minimum number of samples are taken to ensure that an adequate confidence is achieved in the number of samples (after EPA G-4). Because no segregation of debris will be performed based on screening data, it follows that debris results will have wider variation than soil results. Consequently, a higher sampling frequency is stipulated for debris than that for soils (1 per 5 containers, or 18 yd³ vs. 1 per 7 containers, or 25 yd³, respectively). The sampling frequency was designed not only to provide some statistical confidence, but also to facilitate implementation in the field as debris is excavated. Preliminary volumetric estimates of the total debris from the excavation are ~125 yd³. The scheme for random sampling is given in Table 2-5.

PROCESS SAMPLING

RMRS will estimate the relative percentage of each debris type within each filled waste container. Samplers will then sample each generic type of debris present in the waste container based on professional judgement.

NON RADIONUCLIDES

At least three (3) samples will be taken randomly from the debris wastestream for chemical analysis to evaluate compliance with the WAC. Additional samples beyond those minimally required may be acquired based on the samplers judgement (i.e., waste that is suspected of being hazardous and thus has been separated from the generic "LLW" wastestream (these samples will also be labeled as such (i.e., "nonrandom"))).

EPA SW-846 (Chapter 10, *Sampling Methods*) stipulates that, for the purpose of evaluating solid wastes, the 90% upper confidence limit will be compared against the action levels of interest for decision making (i.e., determination of waste as nonhazardous or hazardous).

DECISIONS AND ERROR LIMITS

Prior to making decisions on the wastestream, the statistical confidence in the data will be established. Based on historical RFETS environmental data, the most likely results are either lognormal or normally distributed data.

ALL SAMPLES/ANALYTICAL SUITES

If the sample quantities are adequate based on variances and mean values of the sample results (specifically EPA G-4 or Gilbert, 1987), sampling is complete; otherwise collect the revised required minimum number of samples for comparison with Waste Acceptance Criteria.

NONRADIONUCLIDES

Consistent with EPA SW-846 (Chapter 10, *Sampling Methods*), for the purpose of evaluating solid wastes, the 90% upper confidence limit will be compared against the action levels of interest for decision making (i.e., determination of waste as nonhazardous or hazardous). If the 90% UCL exceeds the facility WAC, the wastestream (in total) will be designated as unacceptable for disposition at that facility; otherwise, the wastestream is designated as acceptable for disposal without subsequent treatment.

RADIONUCLIDES

If the sum-of-ratios equation (using the 90% UCL of radionuclide in the numerators and WAC action levels for the radionuclides in the denominators) exceeds unity (i.e., one), then the debris wastestream is designated as radioactively contaminated above the receiving facilities license requirements, and alternate disposition will be sought; otherwise, the debris wastestream, in total, is designated as acceptable for disposition as a radioactive waste.

For inventory of the wastestream in units of total activity, the activities of debris category may be multiplied by the percentage of each respective debris type noted by the sampler to derive a weighted average of the total activity within the waste container.

2.5 DQOs TO SUPPORT ON-SITE TREATMENT OF INCIDENTAL WATERS

Incidental waters collected within the excavation and tent structure will be treated at the Consolidated Water Treatment Facility (CWTF) located in Building 891. The analyses specified in Section 3.5 are required by CWTF personnel to assist in the effective treatment of the water. Sampling of the incidental waters will be required on the first batch of water collected from the excavation bottom (if any). Additional incidental waters will be sampled as required by CWTF personnel. The existing CWTF SAP establishes sampling and analytical criteria for the incidental waters following treatment at the CWTF.

TABLE 2-5 RADIOLOGICAL SAMPLING APPROACH FOR THE DEBRIS

| DEBRIS SAMPLING PLAN (all debris) | | | | | | |
|--|----------------------------|----------------------------|--|---|--|--|
| debris volume (yd3), total of project | volume/ sample ratio | # of sampling events | total samples w/ 5 debris types | # of sequential sampling event | random # in 5- container sequence | sequential # of total containers |
| 25 | 50 | 1 | 5 | 1 | 2 | 2 |
| 25 | 40 | 1 | 5 | 2 | 4 | 9 |
| 25 | 30 | 1 | 5 | 3 | 1 | 11 |
| 25 | 25 | 1 | 5 | 4 | 4 | 19 |
| 25 | 20 | 2 | 10 | 5 | 3 | 23 |
| 25 | 18 | 2 | 10 | 6 | 3 | 28 |
| 25 | 10 | 3 | 15 | 7 | 4 | 34 |
| | | | | 8 | 3 | 38 |
| 50 | 50 | 1 | 5 | 9 | 3 | 43 |
| 50 | 40 | 2 | 10 | 10 | 3 | 48 |
| 50 | 30 | 2 | 10 | 11 | 1 | 51 |
| 50 | 25 | 2 | 10 | 12 | 2 | 57 |
| 50 | 20 | 3 | 15 | 13 | 5 | 65 |
| 50 | 18 | 3 | 15 | 14 | 4 | 69 |
| 50 | 10 | 5 | 25 | 15 | 4 | 74 |
| 75 | 50 | 2 | 10 | | | |
| 75 | 40 | 2 | 10 | | | |
| 75 | 30 | 3 | 15 | | | |
| 75 | 25 | 3 | 15 | | | |
| 75 | 20 | 4 | 20 | | | |
| 75 | 18 | 5 | 25 | | | |
| 75 | 10 | 8 | 40 | | | |
| 100 | 50 | 2 | 10 | | | |
| 100 | 40 | 3 | 15 | | | |
| 100 | 30 | 4 | 20 | | | |
| 100 | 25 | 4 | 20 | | | |
| 100 | 20 | 5 | 25 | | | |
| 100 | 18 | 6 | 30 | | | |
| 100 | 10 | 10 | 50 | | | |
| 125 | 50 | 3 | 15 | | | |
| 125 | 40 | 4 | 20 | | | |
| 125 | 30 | 5 | 25 | | | |
| 125 | 25 | 5 | 25 | | | |
| 125 | 20 | 7 | 35 | | | |
| 125 | 18 | 7 | 35 | | | |
| 125 | 10 | 13 | 65 | | | |
| soil/debris containers = 3.6 yd ³ | | | | for debris: 5 containers = 18 yd ³ | | |
| starmet containers = 1.6 yd ³ | | | | filename: debris3.xls | | |

3.0 SAMPLE COLLECTION AND ANALYSIS

The sampling requirements for each sample event to be performed under this SAP are described in the following sections. To fully understand the rationale and methodology for collecting samples, these sections are to be reviewed and used along with the appropriate subsections of Section 2 (the DQOs) of this SAP.

Circumstances may be encountered in which the field supervisor determines that samples not specified in the SAP are required, (e.g. for characterizing spills). In conjunction with the sample coordinator, and project health and safety personnel, additional samples may be collected based on this professional judgement. Rationale for collecting such samples will be described in detail on the sample logsheets used for the project. Changes to this SAP will not necessarily be required in such events. In addition, if conditions are encountered in the field which make the use of a procedure unsafe or inappropriate for the task at hand, the specified procedures may be modified or replaced as long as the modification or replacement procedure is justified and detailed in the sample logsheets, and the resulting data is comparable and adequate to meet the objectives of the project.

All activities will be conducted in accordance with the Activity Hazards Analysis and Health and Safety Plan (RMRS, 1998b) prepared for this job. Unanticipated hazards or conditions encountered during this project will be managed in accordance with this RMRS policy statement: "In the event unanticipated hazards or conditions are encountered, the project activities will pause to assess the potential hazard or condition. The potential hazard or condition will be evaluated to determine the severity or significance of the hazard or condition. Based on this initial evaluation, a determination will be made whether to proceed with controls currently in place; segregate the hazard or condition from the project activity, if it can be done safely; or curtail operations to address the unexpected hazard or condition. Concurrence to proceed down the selected path must be obtained from the RMRS Environmental Restoration Director or designee. In addition, the resumption of field activities involving radiological issues will be in accordance with Article 345 of the RFETS Radiological Control Manual." Note: "Unanticipated Hazards or Conditions" do not replace conditions which require emergency response, rather, they ensure that all work is performed based on an informed approach in regards to all potential hazards.

3.1 EXCAVATION BOUNDARY SAMPLING

The intent of this section is to provide a process for collecting radionuclide, VOC and cyanide samples specified by Section 2.1 of this SAP.

As described in the DQOs section, excavation boundary sampling for radionuclides, will be performed using a grid established over the entire excavation, while sampling for VOCs and cyanides will be limited to areas found to contain these wastestreams during excavation. As such, location reference points (stakes) will be established around the perimeter of the excavation, to assist in assigning x,y coordinates to significant wastestreams such as cemented cyanides/still bottoms.

Because of the hazards associated with entry into steep-sided, unsupported excavations, field personnel will not enter the excavation to collect samples. Each sample described in this section will be collected from the excavation by means of the excavator bucket or similar equipment. The excavated soil contained in the excavator bucket will be elevated from inside the excavation to the ground surface. Samples will be collected directly from the exposed soil at the surface of the excavator bucket using new disposable sampling spoons/scoops, or decontaminated stainless steel spoons/scoops. The following steps will be used to insure that the samples are as representative of the soil in the bucket, as practical.

Samples for non-volatile analysis (isotopic and cyanide samples):

- Collect a scoop/spoon full of soil from each of the four exposed corners of the bucket. These subsamples shall be collected approximately 6-9" from the corners to minimize direct contact between the sampled soil and the bucket
- Place each scoop of soil directly in a sealable plastic bag of at least 1 gallon capacity. After the four subsamples are placed in the bag, seal the bag
- Homogenize the soil by turning over the bag several times and using hand movement to break up cohesive clumps of materials, as practical. This activity should take between one and two minutes to insure a thoroughly homogenized soil
- If the soil is relatively cohesive and "clumping" results in a less than ideal homogenization (mix), the sampler will note this fact on the corresponding logsheet

- Using the same scoop that was used to collect the four subsamples, collect enough material to fill the appropriate sample jars (e.g., for radionuclide or cyanide analysis)

Samples for volatile analysis:

- Do not composite samples for VOC analysis. With the same scoop/spoon used to collect the nonvolatile samples described above, fill the appropriate sample jar with soil from the middle of the exposed surface of the excavator bucket. Fill the jar completely, minimizing void spaces.

The excavator bucket will be decontaminated prior to the sampling event, but will not be decontaminated between individual sampling grids. To minimize cross contamination, samples will be collected from soil that is not directly in contact with the bucket. Initial decontamination will be performed in accordance with F0.03, *General Equipment Decontamination*, Section 5.3, *Cleaning Procedures for Stainless Steel or Metal Sampling Equipment*. One exception is noted. The equipment (e.g., excavator bucket) is not expected to be removed from the exclusion zone (posted High Contamination Area or Contamination Area) prior to decontamination.

3.1.1 Sampling Excavation Boundary for Radioisotopes

Samples will be collected on the excavation periphery to evaluate if the radionuclide cleanup target levels specified in Table 3-1 of the PAM have been met. The T-1 excavation boundaries are expected to be approximately 188'-200' x 15'-20' x 10' deep, with excavation proceeding into the native soil. A systematic grid will be used to locate radionuclide contamination remaining after excavation. Section 2.1 defines the number of samples required in accordance with *Statistical Methods for Environmental Pollution Monitoring* (Gilbert, 1987). A sampling grid of approximately 10' x 20' will provide the confidence specified in Section 2.1. This grid pattern requires the collection of approximately 42 samples (excluding QC) from a 200' long by 20' wide excavation bottom (Figure 3-1, and Table 3-1).

In addition to the 42 samples stated above, another 6 samples will be collected from the excavation bottom. Two samples will be collected from each of three grid cells representing the east, west and center portion of the trench bottom (Figure 3-1). These will be used to evaluate intracell radiological variability on the excavation bottom (See Section 2.1.1).

Additional excavation and sampling will be required if samples exceed the cleanup target levels specified in the PAM, and the limiting conditions for total depth specified in the PAM have not

FIGURE 3-1 T-1 EXCAVATION BOTTOM AND WALL SAMPLING LOCATIONS

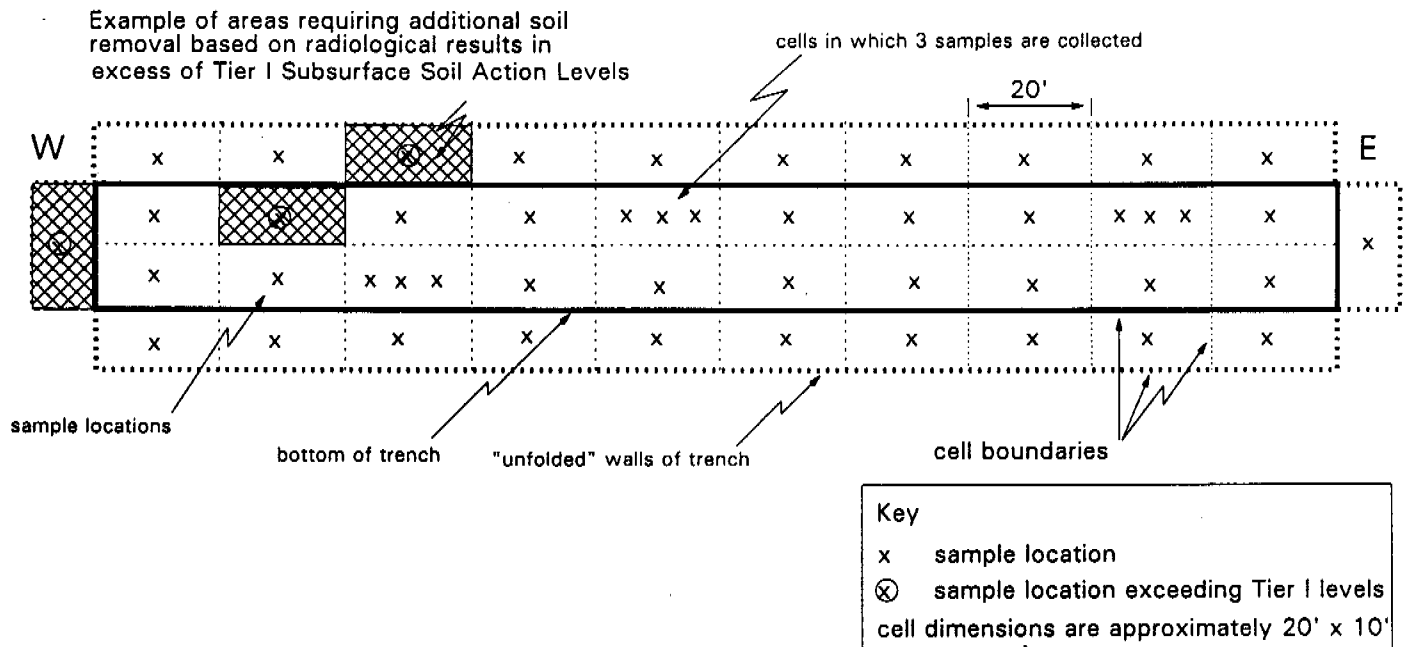


TABLE 3-1 EXCAVATION BOUNDARY SAMPLES

| Analysis Method | Line Item Code | Excavation Samples | QC Samples | Total Samples | Container, Preservation, Holding Time |
|--|----------------|---|--------------------------------------|---------------|--|
| Gamma Spectroscopy | RCO3A002 | 48 | 3 (duplicates) (at least 1 in 20) | 51 | 16 oz wide mouth glass or - Standard fixed geometry sample container as required by gamma spectroscopy subcontractor |
| Total Cyanide SW846-9010A | SS06B013 | 0-15 | 0-1 (duplicate) | 0-16 | 125 ml wide-mouth glass at 4°C for 14 days |
| Total VOAs by SW846-8240B/8260A | SS01B006 | 2-15 | 1 (duplicate) | 2-16 | 60 ml glass wide-mouth with Teflon liner at 4°C for 14 days |
| VOAs: Rinsates Blanks by SW846-8240B/8260A | SS01B005 | 0-1 (not required if new disposal sampling spoons are used) | 0-1 (1/20 regular samples) | 0-1 | 2-40 ml glass vials, Teflon-lined septa lid, HCl pH<2, 4°C for 14 days |
| VOA: Trip Blanks by SW846-8240B/8260A (prepared away from field) | SS01B005 | 1-3 | 1/cooler for off-site VOC samples | 1-3 | 2-40 ml glass vials, Teflon-lined septa lid, HCl pH<2, 4°C for 14 days |
| Radiological Screen to support off-site shipping requirements | OS01A03 | TBD by Radiological Engineering | N.A. | TBD | 60 ml glass wide-mouth, 6 months. |

been met. The area (cell) surrounding the "failed" sampling locations will be re-excavated, including sidewalls grid cells, as necessary. Following this excavation, samples will be collected from the center of the re-excavated cell (Figure 3-1).

Table 3-1 shows the number and types of regular and quality control samples expected for the T-1 excavation boundary sampling event. These samples will be used to document the undisturbed boundaries of the excavation and to evaluate attainment of the cleanup target levels.

3.1.2 Sampling Excavation Boundary for VOCs and Cyanide

Points in the grid cell centers will be sampled for VOCs and cyanide in the areas that immediately encompass (i.e., that are closest to) the point location(s) where still bottom or cemented cyanide wastes were encountered within the trench. This approach will require the collection of approximately five (5) of each type of sample (one from the cell which originally contained the material and four samples from cells bounding the original cell) in the areas that these wastes were encountered within the trench.

In the event that no VOCs are detected during the project (e.g., field screening, still bottoms, or DU sampling), then at least two VOC samples will still be collected from the excavation bottom. An attempt will be made to bias these samples to locales within the trench that may indicate greater likelihood of VOC contamination. It is recognized that this identification will be difficult based on the lack of other objective evidence, however professional judgement will be used. These locations will be chosen in the field and documented on the appropriate logsheets.

3.2 SAMPLING TO EVALUATE RETURN OF SOIL TO THE EXCAVATION

Samples will be collected to evaluate return of stockpiled soils to the excavation. Excavated soil will be visually observed and field screened as it is removed from the trench. Several stockpiles/containerization options are anticipated to be used for segregation based on the results of the visual observations and field screening. For the purposes of this section, sample containers, line item codes, preservation methods, etc., will be the same as those specified for the respective analyses specified in Table 3-1 of the previous section.

3.2.1 Radiological and VOC Screening Verification Sampling

Radiological screening will be performed in support of segregation activities associated with excavation of T-1 soils. This section focuses on a real-time radiological field screening approach to identify contamination in the excavated soils.

During excavation of T-1 soil will be screened with a FIDLER. Generally, screening will be conducted on the exposed soil in each excavator bucket of soil removed from the excavation (approximately 1.5 - 2 yd³). The rate of screening will be continuously evaluated by radiological

controls personnel and may be reduced if radioactivity is not detected above the levels described below.

FIDLER monitoring will be performed in accordance with Radiological Operating Instruction (ROI) - 6.6, Operation of the Bicorn FIDLER. Soil will be segregated in accordance with the DQO requirements established in Section 2.2. Per the PAM, soils having FIDLER readings less than three times background (approximately 5,000 CPM) will not require further radiological characterization; however, three composite gamma spectroscopy samples (as described in Section 2.2.1) will be collected randomly around Stockpile 1 for verification purposes. Soil having radionuclide content greater than three times background will be segregated for more quantitative isotopic characterization by gamma spectroscopy.

In order to verify the VOC screening assumptions stated in Section 2.2.1, three VOC grab samples will also be collected randomly around Stockpile 1.

3.2.2 Sampling Soils in Excess of 5,000 CPM

Soil exhibiting FIDLER readings in excess of 5,000 CPM will be sampled in the following manner.

Samples will be collected directly from the exposed surface soil of the front end loader bucket or waste container receiving the soil. New disposable sampling spoons/scoops, or decontaminated stainless steel spoons/scoops will be used. Table 2-3 lists the rate and location (front end loader buckets or filled waste containers) of the samples collected for radiological (gamma spectroscopy) analysis. The following steps will be used to ensure that the samples are as representative of the soil in the bucket/container, as practical.

Samples for non volatile analysis (e.g., isotopic samples):

- Collect a scoop/spoon full of soil from each of the four exposed corners of the front end loader bucket or four corners of the waste container (as appropriate). These subsamples shall be collected approximately 6-9" from the corners to minimize direct contact between the sampled soil and the bucket/container walls
- Place each scoop of soil directly in a sealable plastic bag of at least 1 gallon capacity. After the four subsamples are placed in the bag, seal the bag
- Homogenize the soil by turning over the bag several times and using hand movement to break up cohesive clumps of materials, as practical. This activity should take between one and two minutes to insure a thoroughly homogenized soil
- If the soil is relatively cohesive and "clumping" results in a less than ideal homogenization (mix), the sampler will note this fact on the corresponding logsheet

- Using the same scoop that was used to collect the four subsamples, collect enough material to fill the appropriate sample jars

Samples for volatile analysis:

- Do not composite samples for VOC analysis. With the same scoop/spoon used to collect the nonvolatile samples described above, fill the sample jar with soil from the middle of the exposed surface of the front end loader bucket or waste container, as appropriate. Fill the jar completely, minimizing void spaces

The front end loader used for transporting soil from the excavation to the stockpiles will not be decontaminated to support sampling. To minimize cross contamination, samples will be collected from soil that is not directly in contact with the bucket (per above bullets).

3.3 SAMPLING TO SUPPORT EVALUATION OF SOIL DESTINED FOR OFFSITE DISPOSAL

Radioactive soil destined for direct offsite disposal by RMRS will be required to meet the DQOs described in Section 2.3. These DQOs were established to meet the analytical WAC requirements for either disposal as LDR compliant mixed waste at Envirocare or as LLW at Envirocare or the NTS. The Envirocare WAC requires that all chemical analysis be conducted at a Utah Department of Health, Division of Laboratory Services, certified laboratory (Note: this is not required for geotechnical or radiochemical analyses). Table 3-2 lists the analytical parameters necessary to evaluate the soil with respect to the WAC.

3.3.1 Pyrophoricity Sampling

As described in Section 2.3, samples will be collected from soil destined for offsite shipment to confirm that the soils are not pyrophoric. These samples will be collected on a biased, worst case basis. For the purpose of this paragraph, "worst case" is defined as oxidized DU material containing the lowest fraction of soil (i.e., the greatest fraction of oxidized uranium, See Section 2.3.1 for further definition). Samples of the DU material are expected to be collected either out of the excavator bucket, front end loader bucket or waste container with a spoon, scoop or similar piece of equipment. At least three samples are expected to be collected when potentially oxidized DU is first encountered. Additional samples will be collected at the discretion of the field supervisor (See Section 2.3). To perform the DTA analysis and others specified in Section 2.3, 5-10 ml of sample material is required. PA01A002

3.3.2 Chemical and Radiological Sampling

Chemical and radiological samples will be collected using the methodology described in Section 3.2.2. Radiological sampling location (sequentially filled waste container) and frequency is established in Table 2.3. Chemical and Geotechnical frequency is described in Section 2.3.2. Table 3-2 lists the analytical parameters that will be sampled for to evaluate the soil wastestream with respect to the Envirocare WAC.

TABLE 3-2 SAMPLE TYPES/ANALYTICAL METHODS TO MEET ENVIROCAR'S MIXED WASTE WAC FOR SOIL

| Analytical Method | Line Item Code | Analytes | # of Samples | Utah cert. required | Container | Preservative | Holding Time |
|--------------------------------|----------------------|--|-------------------------|---------------------|---|-------------------------|---|
| Gamma Spectrometry (offsite) | TBD | gamma emitting radioisotopes | 3+ | No | TBD-as required by laboratory | None | 6 months |
| Isotopic analysis | RC01B003 | Uranium, americium, and plutonium isotopes | 3+ | No | 250-ml wide mouth glass jar (or may combined with gamma spec sample) | None | 6 months |
| SW-846, Section 8.3 | SS08B005 SS08B004 | Reactive Sulfide Reactive Cyanide | 3+ | Yes | combine with TCLP jar | Cool, 4° C | 7 days 14 days |
| SW-846 Method 9045 | SS08B003 | Soil pH or corrosivity | 3+ | Yes | combine with TCLP jar | Cool, 4° C | ASAP (up to 14 days) |
| SW-846 Method 8240B/8260A | SS01B006 | Volatiles | 3+ | Yes | 60-ml wide mouth glass jar with Teflon lined lid | Cool, 4° C | 14 days |
| SW-846 Method 8240B/8260A | SS01B005 | Volatiles | 1 trip blank per cooler | Yes | 2 x 40 ml VOA vials - Teflon lined septa lids | Cool, 4° C, HCl to pH<2 | 14 days |
| TCLP SW-846 (311) (extraction) | SS08B008 | 8 TCLP metals + Cu, Zn, Sb, Be, Ni, Ti, V (Method 6010A, except Hg; Method 7470) all analyses with detection levels < RCRA UTS. Note use Method 7841 for thallium if can't meet UTS levels with Method 6010A | 3+ | Yes | 1-L wide mouth glass jar with Teflon lined lid, as appropriate, so that the TCLP can be combined with other samples listed in this table. | Cool, 4° C | 180 days from extraction, 180 days from extraction to analysis, except Hg: 28 days to extraction, 28 days from extraction to analysis |
| | SS08B011 | TCLP Semivolatiles (Method 8270/8270A) | | | | | 14 days to TCLP extraction, 7 days from preparative extraction, 40 days from extraction to analysis |
| | SS08B013 | TCLP Chlorinated Herbicides (Method 8150) | | | | | 14 days to TCLP extraction, 7 days from preparative extraction, 40 days from extraction to analysis |
| | SS08B012 | TCLP Organochlorine Pesticides (Method 8080/8081) | | | | | 14 days to TCLP extraction, 7 days from preparative extraction, 40 days from extraction to analysis |
| | SS08B010 | TCLP Volatiles (Method 8240B/8260A) | | | | | 14 days to extraction, 14 days from extraction to analysis |
| SW-846 Method 8278B | SS02B006 | Semivolatiles | 3+ | Yes | 250-ml wide mouth glass jar with Teflon lined lid | Cool, 4° C | 14 days to extraction, 40 days from extraction to analysis |
| ASTM D 2216 | TBD | Moisture Content | | | | | |
| ASTM D-698 | | Optimum Moisture Content | 3 | No | 5 gallon plastic bucket | None | N.A. |
| ASTM D 422 | | Particle-size Distribution of Soils | | | | | |
| Determined by Laboratory | N A | Envirocare evaluation (finger print) samples | ≥ 5 | N.A. | 2 pound, as required | None | None |

3.4 SAMPLING TO SUPPORT EVALUATION OF DEBRIS AND SECONDARY WASTESTREAMS

Debris and secondary wastestreams generated during this project will be characterized to support waste packaging, storage, and disposal requirements. The majority of the non-soil wastes generated during this project will include:

- Debris removed from T-1
- Used PPE

If other wastestreams or disposal options are identified, the project manager, along with the sample and waste managers will determine any additional analytical requirements. These will be documented in the project logbook.

3.4.1 Debris Sampling

Debris may be radioactive and/or be contaminated with or contain hazardous contaminants. The debris will be evaluated for disposal as low level radioactive waste or LDR-compliant low level-mixed waste. The debris will be sampled to provide the information necessary to evaluate the wastestream for disposition at Envirocare. Analytical results obtained for this evaluation will be sufficient for other disposal options as well. The debris will have to be evaluated with respect to the WAC contained in the facilities Customer Information Manual (Envirocare, 1996). The WAC requires that all chemical analyses be conducted at a Utah Department of Health, Division of Laboratory Services, certified laboratory (Note: this is not required for radiochemical analyses). Table 3-3 lists the analytical parameters necessary to evaluate the debris with respect to the WAC. Samples from debris are expected to be collected by cutting "coupons" from the debris using conventional scissor type cutters or a sawzall tool, or equivalent. Other equipment may be used as appropriate to collect sample material, depending on material characteristics. Sample material (e.g., coupons) will be placed directly in the appropriate sample containers described in the following table. Section 2.4 lists the sampling frequency required for the project.

3.4.2 PPE Evaluation

PPE generated from this project will be evaluated with respect to potential chemical and radiological contamination.

It is anticipated that the majority of spent PPE generated during the project will be classified as radioactive waste, however some PPE may be essentially free from any form of contamination. Some decontamination of PPE may be required to support disposal. If the PPE appears to be stained and/or heavily soiled, the PPE will be decontaminated so that it no longer contains significant soiling or staining, at which point it will be considered free of chemical contamination. Decontamination/cleaning, if required, will take place within the tent structure or at the main decontamination facility.

**TABLE 3-3 SAMPLE TYPES/ANALYTICAL METHODS TO MEET ENVIROCAR'S MIXED WASTE WAC FOR
DEBRIS**

| Analytical Method | Line Item Code | Analytes | # of Samples | Utah cert. required | Container | Preservative | Holding Time |
|-------------------------------|----------------|--|-------------------------|---------------------|---|-------------------------|---|
| Gamma Spectrometry (onsite) | RC03A005 | gamma emitting radioisotopes | table 2-5 | No | 16 oz wide mouth glass | None | 6 months |
| Gamma Spectrometry (offsite) | TBD | gamma emitting radioisotopes | 3+ | No | TBD-as required by laboratory | None | 6 months |
| Isotopic analysis | RC01B004 | Uranium, americium, and plutonium isotopes | 3+ | No | 250-ml wide mouth glass jar (or may combined with gamma spec sample) | None | 6 months |
| SW-846, Section 8.3 | SS08B005 | Reactive Sulfide | 3+ | Yes | combine with TCLP jar | Cool, 4° C | 7 days |
| | SS08B004 | Reactive Cyanide | | | | | 14 days |
| SW-846 Method 9045 | SS08B003 | Soil pH or corrosivity | 3+ | Yes | combine with TCLP jar | Cool, 4° C | ASAP (up to 14 days) |
| SW-846 Method 8240B/8260A | SS01B006 | Volatiles | 3+ | Yes | 250-ml wide mouth glass jar with Teflon lined lid | Cool, 4° C | 14 days |
| SW-846 Method 8240B/8260A | SS01B005 | Volatiles | 1 trip blank per cooler | Yes | 2 x 40 ml VOA vials - Teflon lined septa lids | Cool, 4° C, HCl to pH<2 | 14 days |
| TCLP SW-846 1311 (extraction) | SS08B008 | 8 TCLP metals + Cu, Zn, Sb, Be, Ni, Ti, V (Method 6010A, except Hg, Method 7470) all analyses with detection levels < RCRA UTS. Note use Method 7841 for thallium if can't meet UTS levels with Method 6010A | 3+ | Yes | 1-L wide mouth glass jar with Teflon lined lid, as appropriate, so that the TCLP can be combined with other samples listed in this table. | Cool, 4° C | 180 days from extraction to analysis, except Hg: 28 days to extraction, 28 days from extraction to analysis |
| | SS08B011 | TCLP Semivolatiles (Method 8270/8270A) | | | | | 14 days to TCLP extraction, 7 days to preparative extraction, 40 days from preparative extraction to analysis |
| | SS08B013 | TCLP Chlorinated Herbicides (Method 8150) | | | | | 14 days to TCLP extraction, 7 days to preparative extraction, 40 days from preparative extraction to analysis |
| | SS08B012 | TCLP Organochlorine Pesticides (Method 8080/8081) | | | | | 14 days to TCLP extraction, 7 days to preparative extraction, 40 days from preparative extraction to analysis |
| | SS08B010 | TCLP Volatiles (Method 8240B/8260A) | | | | | 14 days to extraction, 14 days from extraction to analysis |
| SW-846 Method 8270B | SS02B006 | Semivolatiles | 3+ | Yes | 250-ml wide mouth glass jar with Teflon lined lid | Cool, 4° C | 14 days to extraction, 40 days from extraction to analysis |
| Determined by Envirocare | N.A. | Envirocare evaluation (finger print) samples | ≥5 | N.A. | 2 pound, as required | None | None |

To meet the conditions of unrestricted release, the PPE must:

- be free of appreciable staining and/or heavy soiling to address chemical concerns
- meet the requirements for unrestricted release in procedure 4-S23-ROI-03.02, *Radiological Requirements for Unrestricted Release*, and the evaluation criteria specified in procedure 4-Q97-REP-1003, *Radiological Evaluation for Unrestricted Release of Property/Waste*, to address radiological concerns

PPE that cannot meet these requirements will be evaluated on a case by case basis, including the probable disposition (off-site), and the collection of appropriate samples to support disposition. If radioactively contaminated PPE remains free of appreciable staining and/or heavy soiling, it will be evaluated for disposition as LLW. Three composite samples will be collected randomly during the project to characterize the PPE. Each sample will be made up of the various outer components of the PPE, cut away from the PPE using scissors. The components of the PPE sampled will include (at a minimum) portions of outer booties, outer gloves and outer anti contamination clothing. These samples will be analyzed by gamma spectroscopy.

3.5 SAMPLING TO SUPPORT ON-SITE EVALUATION OF INCIDENTAL WATERS

Incidental waters collected within the excavation and tent structure will be treated at the CWTF. The analyses specified in Table 3-4 are required by CWTF personnel to assist in the effective treatment of the water. Sampling of the incidental waters will be required on the first batch of water collected from the trench bottom (if any). Additional incidental waters will be sampled as required by CWTF personnel.

Samples may be collected directly out the storage tank by use of a bailer or similar device. The recovered water may then be poured into a large previously decontaminated bucket. Samples will then be collected by pouring the contents of the bucket through a funnel or similar device into the appropriate sample container. This action will be conducted over secondary containment. Quality control (QC) samples (e.g., trip blanks, duplicates) are not required by CWTF personnel for this activity.

TABLE 3-4 T-1 INCIDENTAL WATER SAMPLE PARAMETERS

| ANALYTE | METHOD(S) | LINE ITEM CODE | BOTTLES | HOLDING TIME | COMMENT |
|--|--|----------------------|--|---|--|
| Volatile Organic Compounds + Tentatively Identified Compounds | 8240B/8260A | SS01B005 | 2-40 ml glass vials, HCl to pH <2, 4° C | 14 days | |
| Semivolatile Organic Compounds + Tentatively Identified Compounds | 8270B | SS02B003 | 3-1 L amber glass, 4° C | 7 days until extraction, 40 days after extraction | |
| PCBs | 8080/8081 | SS03B005 | 1-1 L amber glass, 4° C | 7 days until extraction, 40 days after extraction | |
| Total Target Analyte List (TAL) Metals | 6010 and 7000 series methods | SS05B021 | 1-1 L poly, HNO ₃ to pH <2, 4° C | 6 months, except mercury - 28 days | CLP-TAL detection limits required |
| Total Cyanide | 335 series methods, or 9010A/ 9012 | SS06B012 | 500 ml poly, NaOH to pH >12, 4° C | 14 days | Detection limit of 0.005 mg/L required |
| Total Organic Carbon | 415 series methods, or 9060 | SS06B025 | 500 ml poly, H ₂ SO ₄ to pH <2, 4° C | 28 days | |
| Nitrate + Nitrite | 353 series methods | SS06B022 | | | |
| Sulfide | 9030 or 376 series methods | SS06B039 | 1-1 L poly, 4° C pH > 12 (NaOH) & Zinc Acetate preservative (may be added at laboratory) | 7 days | |
| Ignitability/flashpoint | ASTM Standard D-93-79 or D-93-80 or D-3278-78 or SW 846 1010 | SS08B001 | 8 oz. glass, 4° C | 28 days | |
| Rad Screen: (for shipping only) (Gross alpha & beta) or gamma spectroscopy | Gas Proportional Counting, or gamma spec | OS01A02 RCO3 A001 | 1-125 ml poly, HNO ₃ to pH <2 2-L Marinelli | 6 months | |
| Radiochemistry: Plutonium, Americium and Uranium isotopic | Alpha Spectrometry or may substitute gamma spec | RC01B001 | 2-4 L poly, HNO ₃ to pH <2 | 6 months | |

3.6 QUALITY CONTROL SAMPLES

This section states the general approach for QC sample collection for this project. Additional details regarding these samples are given in the tables of the respective sections of this document.

QC samples will be collected from the excavation boundary, and from samples used in “put back” determinations as described in Sections 3.1 and 3.2., respectively. Some QC samples such as duplicates will not normally be required for waste characterization samples.

The following types of QC samples will be collected to support the T-1 remediation:

- **Duplicates:** Duplicate (collocated) samples will be collected in the same manner and analyzed by the same analytical methods, in the same laboratory as the regular grab samples described in Sections 3.1 and 3.2. These samples will be collected at the rate of at least one duplicate in twenty regular samples. These samples will be submitted blind to the laboratory. All duplicate samples will be collected using the same sampling equipment used for collection of the regular samples. Sampling equipment will not be decontaminated while collecting regular and QC samples from the same location. Duplicates will not be required for evaluating offsite disposal options
- **Equipment rinsate blanks:** These samples will be prepared by collecting distilled water, poured over decontaminated sampling equipment, between collection of regular VOC samples. These blanks will be submitted with the regular samples. These samples will be preserved to a pH<2 with hydrochloric acid (HCl), and will be analyzed for VOCs, as appropriate. These samples will not be required if collecting samples using new, disposable sampling equipment.
- **Trip blanks:** Trip blank samples will be shipped with coolers sent off-site containing samples being analyzed for VOCs. These trip blanks will be pre-prepared (not in the field) with minimal headspace and preserved to a pH<2 with HCl

All VOC samples sent to a laboratory for analysis will be analyzed in accordance with SW846 method 8260A (EPA, 1992).

4.0 SAMPLE DESIGNATION

Each sample will be assigned a unique sample number in accordance with the RFETS, ASD requirements. The unique sample number will be broken down into three parts. These are:

- The Report Identification Number (RIN)
- The Event Number
- The Bottle Number

The first part of the number will be the RIN which is assigned by the ASD. The RIN is used by the ASD to track/file analytical data. Unique RINs will be assigned to different types of sampling events (eg., excavation boundary vs. putback samples). The RIN will be a 7 digit alpha-numeric code starting with "98" for 1998. This RIN will be followed by a dash "-" and then the event number. The event number is a three digit code, starting with "001" under the RIN and will be sequential. Each typical sample location will have a unique event number under the RIN. QC samples (e.g., duplicates) will have unique event numbers to support a "blind" submittal to the analytical laboratories. The event number will be followed by a period "." and then the sequential bottle number. The bottle number will be a three digit code starting with "001" and will be sequential under each event number. The bottle number will be used to identify individual sample containers under the same location (same event number).

In addition to the sample numbering scheme described above, each sample will require the following information:

Sample Type

Location Code

QC Code

REAL: Regular Sample
DUP: Duplicate Sample
RNS: Rinsate Sample
TB: Trip Blank Sample

Table 4-1 lists examples of the sample types, and location code blocks available for the T-1 Site Source Removal Project.

TABLE 4-1 T-1 SAMPLE TYPES AND LOCATION CODES

| Sample Type | Sample Type Code | Location Code |
|--|------------------|--|
| Excavation Boundary | EB | T-1 Site (may include identifier corresponding with logsheet location map) |
| Soil Stockpiles (including put-back evaluations and soil destined for offsite disposal) | ST | T-1 (generic description for soil not placed into a container) Use RFETS Waste Environmental System (WEMS) Container Number, where applicable |
| Debris | DB | Use RFETS WEMS Container Number, where applicable T-1 (generic description for debris not directly placed into a container) |
| Incidental Water | IW | T-1 Incidental Water |

5.0 SAMPLING SUPPORT INFORMATION

This chapter describes the sample handling, documentation, and quality assurance requirements necessary to support the successful completion of this project.

5.1 SAMPLE HANDLING PROCEDURES

Samples collected for laboratory analysis will follow *Environmental Management Department (EMD) Operating Procedures Volume I, Field Operations 5-21000-OPS-FO.13, Containerization, Preserving, Handling, and Shipping of Soil and Water Samples*. All water samples will be collected without the use of filters. When reusable sampling equipment is used, the equipment will be decontaminated in accordance with EMD Operating Procedure 5-21000-OPS-FO.03, *General Equipment Decontamination, Section 5.3, Cleaning Procedures for Stainless Steel or Metal Sampling Equipment*. Note that sampling equipment will not be required to be removed from the exclusion zone prior to decontamination.

5.2 DOCUMENTATION

Field data shall be documented on the forms (field log sheets) developed for this project, and in accordance with the referenced procedure. The originator shall authenticate (legibly sign and date) each completed hardcopy of the data. A peer reviewer, someone other than the originator, shall perform a peer review on each hardcopy of data. The peer reviewer shall authenticate each hardcopy completed by the originator. Any modifications shall be lined-through, initialed, and dated by the reviewer (in ink). Data planned for computerized reduction and analysis shall be entered into electronic form in accordance with the current ASD and Soil and Water Database (SWD) requirements.

The QA Records for the project include the field log sheet and chain-of-custody (COC) forms used in the project. Each QA Record is subject to the applicable QA records management procedure(s). Normally, data from the field log sheets and COC forms will be entered into the SWD system to facilitate accessibility. However, use of the SWD system is at the discretion of the project manager, for efficiency, and is not required to provide an adequate assurance of quality. Note that data stored in the SWD system are often the most useful and accessible project records, but are not QA Records.

5.3 QUALITY ASSURANCE

At least 25% of total data set generated under this SAP will be validated. More emphasis will be placed on validating data used to support excavation and "put back" decisions, with less emphasis placed on validation of data used for waste management decisions. Most gamma spectroscopy data used in this project will be generated from an onsite mobile laboratory, used for the first time at RFETS. For the gamma spectroscopy data used in decision making (final excavation or put back determinations), 100% validation will be performed. Data validation will be performed in accordance with the Rocky Flats ASD, Data Assessment Guidelines (DAGR01), but will be done after the data is used for its intended purpose.

Analytical data collected in support of the T-1 remediation will be evaluated using the guidance established by the Rocky Flats Administrative Procedure 2-G32-ER-ADM-08.02, *Evaluation of ERM Data for Usability in Final Reports*. This procedure establishes the guidelines for evaluating analytical data with respect to precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. Completeness goals have been established at 90% for the project (all matrices and all methods). Field precision for non-radiological contaminants of concern is set at $\leq 40\%$ RPD for soils and $\leq 30\%$ for water. For radionuclides a standard measurement of precision, a duplicate error ratio, must be ≤ 1.42 , which is a common precision test statistic used by several radioanalytical laboratories used by RFETS.

Since the T-1 cleanup project is committing large resources of personnel and equipment, field decisions will be based on "Form-1" data faxed directly from the laboratory. This will allow for the timely use of analytical results. Analytical laboratories supporting this task have passed regular laboratory audits by the Rocky Flats ASD.

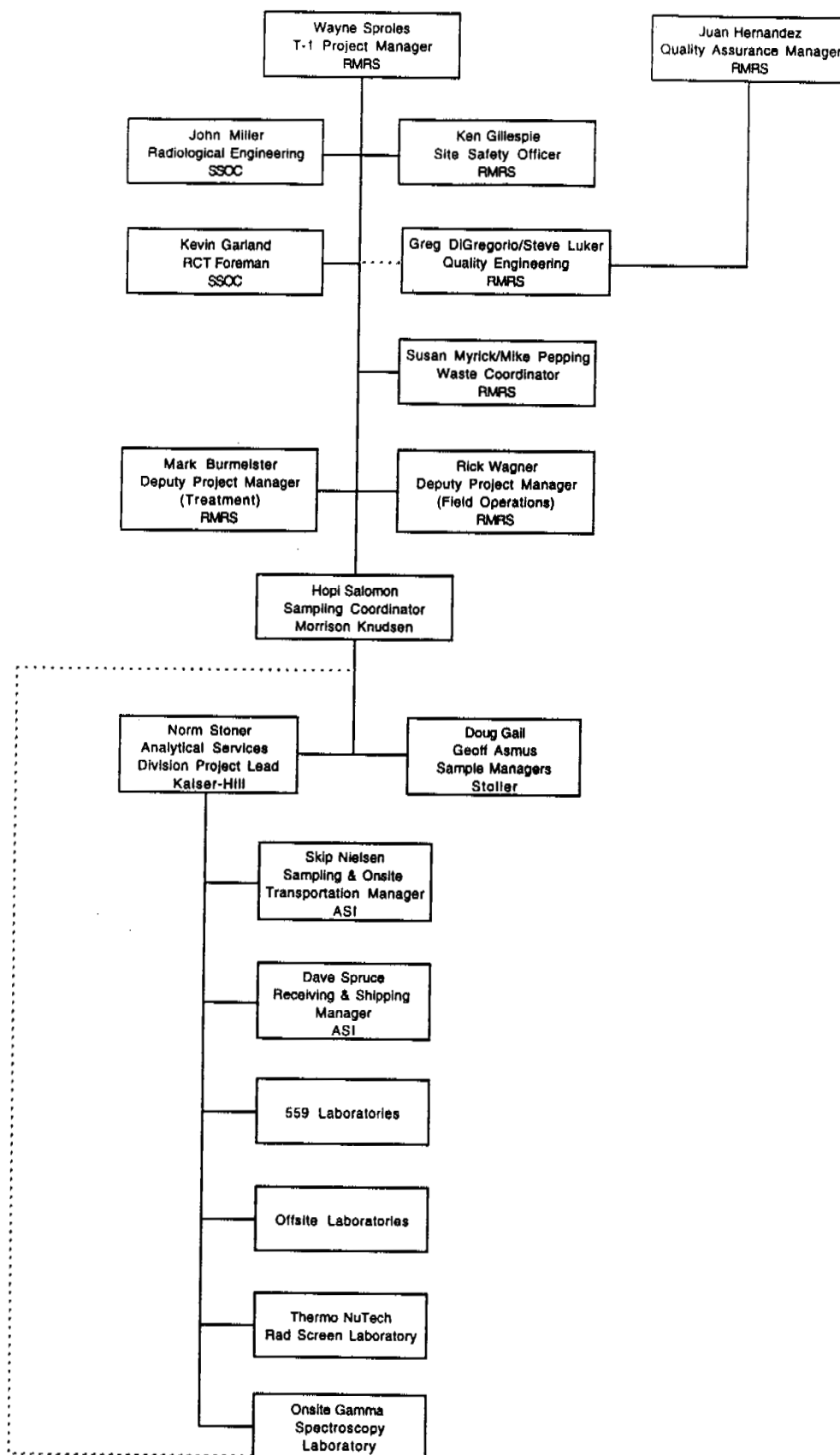
6.0 PROJECT ORGANIZATION

Figure 6-1 represents the organization structure for this project. All personnel performing tasks under this SAP will be trained in accordance with the requirements stipulated in the RMRS Training Scheduling and Records Database. The Sample Coordinator is responsible for overall data flow within the project and ensuring that all data are collected, verified, transmitted and stored in a manner consistent with relevant operating procedures. The Sample Coordinator, or designee, will obtain from the ASD, sample numbers (RINs) and will ensure that appropriate location codes are used. Responsibilities also include working with the Radiological Engineer and Waste Coordinator to insure that the appropriate data is transmitted in a timely manner to support the decision making process.

The sample crew will be responsible for field data collection. The field crews data management tasks will include completing all appropriate data management forms (e.g., logsheets) and completing the chain-of-custody form. The sample crew will coordinate sample shipment with the ASD and Advanced Sciences, Incorporated (ASI) personnel. The Sample Coordinator or designee is responsible for verifying that the chains-of-custody are complete and accurate before the samples are shipped to the laboratory.

RMRS Quality Engineers (QEs) will provide the first level of oversight and support implementation of quality controls within all quality-affecting activities of the project. RMRS oversight activities, which measure compliance of the project with corporate and DOE (site-specific) quality requirements, will complement other facets of oversight implemented by the client(s) (K-H, DOE) and the regulators (CDPHE and EPA). In particular, RMRS will perform surveillance on several of the project's most significant quality-affecting activities including work process control, procedural compliance, document control, management of quality records, measurement and test equipment. Confidence in final project decisions, i.e., those decisions based on screening and sampling data, will also be closely monitored and influenced by RMRS QEs throughout the project.

**FIGURE 6-1 T-1 SITE SOURCE REMOVAL SAMPLING ORGANIZATIONAL
STRUCTURE**



7.0 REFERENCES

DOE, 1992, *Historical Release Report for the Rocky Flats Plant*, Rocky Flats Plant, Golden, CO.

DOE, 1995, *Phase II RFI/RI Report for Operable Unit No. 2.- 903 Pad, Mound, and East Trenches Area*, Rocky Flats Environmental Technology Site, Golden, CO.

DOE, 1996, *Final Rocky Flats Cleanup Agreement*, Rocky Flats Environmental Technology Site, Golden, CO.

EG&G Rocky Flats, Inc., *Background Geochemical Characterization Report*, Rocky Flats Plant, Golden, CO., September.

Envirocare of Utah, Inc., 1996, *Customer Information Manual*, Rev. 0., Salt Lake City, UT, August.

EPA, 1992, *US EPA Test Methods for Evaluating Solid Waste*, Solid Waste-846, third edition, Method 8260A, Rev. 1., November.

EPA, 1994, *Guidance for the Data Quality Objectives Process*, EPA QA/G-4, Final, September.

Gilbert, R. O., 1987, *Statistical Methods for Environmental Pollution Monitoring*, Van Nostrand Reinhold, New York, New York.

RMRS, 1996a, *Quality Assurance Program Description (QAPD)*. RMRS-QAPD-001. Golden, Colorado, December.

RMRS, 1996b, *Draft Trenches and Mound Site Characterization Report*, RF/ER-96-0044.UN, September.

RMRS, 1996c, *Completion Report for the Source Removal at Trenches T-3 and T-4 (IHSS's 110 and 111.1)*, RF/ER-96-0051, Rev 2., September.

RMRS, 1998a, *Final Proposed Action Memorandum for the Source Removal at Trench 1*, IHSS 108, RF/RMRS-97-011, Rev 5.

RMRS, 1998b, *Final Site Specific Health and Safety Plan for the Source Removal at Trench 1*, IHSS 108, RF/RMRS-97-010.

Starmet, 1998, *Pyrophoric Depleted Uranium Source Removal from Rocky Flats Environmental Technology Site T-1 Trench (IHSS) Sampling and Analysis Plan*.

Appendix 1

Plutonium to Americium Ratios for Various Purposes on T-1 Source Removal

**Plutonium to Americium Ratios
for Various Purposes on
T-1 Source Removal Project**

James M. Langsted, CHP
Rocky Mountain Remediation Services
April 2, 1998

Completed by: James M. Langsted, CHP Date: 4/2/98
Peer Reviewed by: Chad J. Brancosini Date: 4/2/98
Approved by: Guillermo [Signature] Date: 4/2/98

I. Introduction

The Trench 1 Source Removal (T-1) project proposes to use High Purity Germanium (HPGe) Gamma Spectrometry for several purposes, including:

- Soil screening for compliance with the Rocky Flats Cleanup Agreement soil action levels
- Screening uranium sludge materials for the presence of plutonium below that required by the processor contracted to take this material
- Sample evaluations for DOT Low Specific Activity
- Inventory of any fissile material removed from Trench-1.

Since the photon emissions from plutonium isotopes are insufficient to allow direct gamma spectrometry with sufficient sensitivity, the photon emissions from Am-241 are measured and the plutonium content determined by ratio. This ratio is determined by calculation from physical and historical knowledge of the material. This paper documents these ratio calculations.

II. Requirements Analysis

To identify the correct ratios to use for the T-1 project, it is necessary to review relevant requirements of the project to assure the correct radionuclide ratios are determined.

A. Soil Levels

The Rocky Flats Cleanup Agreement (Reference 1) specifies subsurface soil action levels for Plutonium-239+240. Thus, for gamma spectrometry of soil to evaluate this subsurface soil action level, the ratio of Pu-239+Pu-240 to Am-241 is appropriate.

B. Uranium Sludge Levels

The material processing subcontractor limits plutonium contamination of the material to less than 50 pCi/g (Reference 2). Section 2.2.2 of that proposal states:

"CMI's nuclear materials license from the State of South Carolina Department of Health and Environmental Control allows the receipt of incidental or trace quantities of special nuclear material including plutonium. The license limit is 200 grams of plutonium ... For material with trace quantities of plutonium less than about 50 pCi/gm, no further analysis inventory (sic) or licensing controls are necessary."

To determine which isotopes are intended by the use of the term "plutonium," a closer review of the requirements was necessary. The subcontractor's radioactive material license (Reference 3) lists as Condition L:

"To receive, possess, process and transfer as trace constituents in materials received for processing activities authorized under the license." "L. Special Nuclear Material (SNM). Any Form, 350 grams total of ²³⁵U or 200 grams of ²³³U or 200 grams of plutonium or any combination of these....¹"

The South Carolina DHEC regulations were not available for review. Since South Carolina is an NRC agreement state, their requirements will closely follow those of the NRC. Title 10 CFR Part 70.4 (Reference 4) states:

¹ It will be necessary to analyze the impact to this license requirement of any U-235 contained in material containing uranium enriched in excess of natural isotopic abundance.

"Special nuclear material means (1) plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission,...."

Thus, this analysis interprets the 50 pCi/g plutonium limit as the sum of all plutonium isotopes contained in the material.

III. Calculations

The appropriate ratios are determined in the following sections.

A. Americium Ingrowth

The T-1 trench was in operation between November 1954 and December 1962. Thus, any material placed in that trench will be at least 35.5 years old when source removal occurs around June, 1998. This plutonium represents the worst-case scenario in which freshly separated material (in which all americium has been removed) was placed in the trench. Americium ingrowth calculated for this material would represent the worst case for estimation of plutonium from the Pu/Am ratio.

B. Weapons Grade Plutonium

Weapons grade plutonium consists of a mixture of:

- Pu-238
- Pu-239
- Pu-240
- Pu-241
- Pu-242
- Am-241 (ingrown from the decay of Pu-241).

To accurately estimate the proportion of Am-241 present in aged weapons grade plutonium, it is necessary to know the proportion of Pu-241 present in the original mixture. The decay of Pu-241 results in the ingrowth of Am-241. In the late 1950s and early 1960s plutonium used in US weapons manufacture came primarily from the plutonium production and purification processes at Hanford, Washington and Savannah River, South Carolina. These materials were higher in Pu-241 than the weapons grade plutonium used in later years and that currently stored at DOE facilities. This is because the Pu-241 isotope present at the time of initial plutonium production decays over time, and is present in lesser amounts in older plutonium mixtures. Thus, it is inappropriate to use plutonium isotopic mixtures from today to understand any plutonium that may have been placed in Trench-1 in the 50s or 60s.

Unclassified average Rocky Flats plutonium isotopic levels for 1959 through 1962 were obtained from a classified notebook on product integrity and surveillance studies (Attachment 1). This data indicates weight percent values of:

| Calendar Year | % ²³⁸ Pu | % ²³⁹ Pu | % ²⁴⁰ Pu | % ²⁴¹ Pu | % ²⁴² Pu |
|---------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| 1959 → 1960 | <0.05 | 93.714 | 5.593 | 0.5932 | <0.05 |
| 1961 → 1962 | <0.05 | 93.817 | 5.486 | 0.5957 | <0.05 |

Data for earlier years were not available. For this analysis, the 1959 - 1960 values were used. Although this year is near the end of the Trench-1 period (1954 and 1962), it is felt to provide a reasonable estimate for the isotopic mixture for any plutonium that may be in the T-1 waste trench. The selected value indicates a slightly lower Pu-241 value than that for 1961 - 1962 which is more conservative for estimating plutonium from americium measurements in later years. Radioisotope half-life and specific activity values were taken from Reference 5.

C. Pu/Am Ratio Determination

To determine the Pu/Am ratio, a spreadsheet (Attachment 2) was developed. Assuming the original plutonium isotopic mix (by weight), this spreadsheet determines the plutonium activity, plutonium decay, and americium ingrowth over time, using equations taken from Reference 6. For validation, the isotopic activity results produced by this spreadsheet were compared with those produced independently by the peer reviewer, Charles J. Bianconi, using a different spreadsheet (PUDCF.xls).

D. Soil Ratio

The ratio of Pu-239+Pu-240 to Am-241 is taken from the spreadsheet. This ratio of 4.41 can be used as a multiplier for the measured Am-241 activity to estimate the Pu-239+240 present in the soil sample. This ratio is specific to the T-1 Source Removal project and may differ from ratios developed from other soil sample data. Any weapons grade plutonium that could have been placed in Trench-1 would have been from the late 1950s or early 1960s, when Pu-241 concentrations would have been higher than they are today. Older plutonium results in a relatively larger amount of Am-241 ingrowth and thus, a lower Pu/Am ratio. Soil samples taken from the environs surrounding RFETS most likely include contributions from multiple sources, including the 903 Pad, 1957 fire, and 1969 fire. It is likely that the Pu/Am ratio from more recent mixtures of material would differ from mixtures of plutonium that may have been placed in T-1.

E. Determination of Uranium Sludge Action Level

The determination of the Am-241 action level corresponding to 50 pCi/g total plutonium is based on the ratio of Am-241 to all plutonium isotopes contained in aged Rocky Flats weapons grade plutonium material.

Dividing the americium activity in that mixture into the sum of the activities for all plutonium isotopes indicates a ratio of 11.7. Dividing the desired action level of 50 pCi/g total plutonium by this ratio yields an Americium-241 activity of 4.28 pCi/g. This is the activity that must be detected to identify a total plutonium action level of 50 pCi/g.

IV. Conclusion

To estimate the quantity of Pu-239+240, multiply the measured Am-241 by 4.41.

In order to achieve satisfactory data quality, a gamma spectrometry method capable of detecting significantly less than 4.28 pCi/g Am-241 is required. To estimate the total plutonium concentration, multiply the measured Am-241 by 11.7.

V. References

1. *Modifications to the Action Levels & Standards Framework for Surface Water, Ground Water, and Soils*, Attachment 5, Rocky Flats Cleanup Agreement, August 30, 1996.
2. *Proposal for Pyrophoric Depleted Uranium Source Removal from Rocky Flats Environmental Technology Site Trench T-1 (IHSS 108)*, Starmet Corporation (Carolina Metals, Inc.).
3. *Radioactive Material License for Carolina Metals, Inc.*, License number 322, Amendment number 18, South Carolina Department of Health and Environmental Control (DHEC).
4. Title 10, *United States Code of Federal Regulations*, Part 70.4.
5. Nuclear Safety Technical Report, *Safety Analysis and Risk Assessment Handbook*, RFP-5098, Safety Analysis/Nuclear Engineering, Rocky Flats Environmental Technology Site, Golden, CO, April 22, 1997.
6. Nuclear Safety Technical Report, *Reference Computations of Public Dose and Cancer Risk from Airborne Releases of Plutonium*, RFP-4910, Vern L. Peterson, Rocky Flats Environmental Technology Site, Golden, CO, December 23, 1993.

AVERAGE ROCKY FLATS PLUTONIUM ISOTOPIC LEVELS

CALENDAR

| <u>YEAR</u> | <u>% ²³⁸Pu</u> | <u>% ²³⁹Pu</u> | <u>% ²⁴⁰Pu</u> | <u>% ²⁴¹Pu</u> | <u>% ²⁴²Pu</u> |
|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| 1959-1960 | <0.05 | 93.714 | 5.593 | 0.5932 | <0.05 |
| 1961-1962 | <0.05 | 93.817 | 5.486 | 0.5979 | <0.05 |
| 1963-1964 | " | 94.398 | 4.854 | 0.6482 | " |
| 1965-1966 | " | 93.586 | 5.823 | 0.5610 | " |
| 1967-1968 | " | 93.451 | 5.953 | 0.5670 | " |
| 1969 | " | 93.538 | 5.953 | 0.4790 | " |
| 1970 | " | 93.450 | 5.965 | 0.4850 | " |
| 1971 | " | 93.533 | 5.929 | 0.4380 | " |
| 1972 | " | 93.513 | 5.939 | 0.4480 | " |
| 1973 1 st Qtr. | " | 93.559 | 5.943 | 0.3980 | " |
| 1973 2 nd Qtr. | " | 93.642 | 5.904 | 0.4160 | " |
| 1973 3 rd Qtr. | " | 93.649 | 5.896 | 0.4190 | " |
| 1973 4 th Qtr. | " | 93.536 | 5.931 | 0.4870 | " |
| 1974 1 st Qtr. | " | 93.546 | 5.910 | 0.5010 | " |
| 1974 2 nd Qtr. | " | 93.596 | 5.891 | 0.4700 | " |

Plutonium stream average data was utilized by the Product Integrity and Surveillance department while conducting the Stockpile Reliability Evaluation Program surveillance tests on pits. The data originated in analytical laboratory reports of plutonium castings; later assembled by the Quality Engineering group responsible for monitoring WR plutonium quality.

Source: Greg Spencer 4/1/98

REVIEWED FOR CLASSIFICATION/UCNI

By PA [Signature]
Date 04-01-98 (U/NU)

Am/Pu Ratios for Aged Weapons Grade Plutonium

| Aged Plutonium Mixture | | | Age= | | 35.5 years | | |
|------------------------|--------------------------|----------------------------------|-----------------------|----------------|------------|------------------|--------|
| Isotope | Original Mixture (wt. %) | Specific Activity (Ci/g-isotope) | Original Mixture (Ci) | Half Life (yr) | (Ci) | Aged Mixture (g) | (wt%) |
| Pu-238 | 0.05 | 1.71E+01 | 0.00855 | 87.74 | 6.46E-03 | 3.78E-04 | 0.04 |
| Pu-239 | 93.714 | 6.22E-02 | 0.05829 | 2.41E+04 | 5.82E-02 | 9.36E-01 | 93.755 |
| Pu-240 | 5.593 | 2.28E-01 | 0.012752 | 6.54E+03 | 1.27E-02 | 5.57E-02 | 5.580 |
| Pu-241 | 0.5932 | 1.03E+02 | 0.610996 | 14.4 | 1.11E-01 | 1.07E-03 | 0.1076 |
| Pu-242 | 0.05 | 3.93E-03 | 1.97E-06 | 3.76E+05 | 1.96E-06 | 5.00E-04 | 0.05 |
| Am-241 | | 3.43E+00 | | 432.2 | 1.61E-02 | 4.69E-03 | 0.47 |
| Total | 100.00 | | 0.69059 | | 2.04E-01 | 9.99E-01 | 100.00 |

Total Pu 1.88E-01
 Total Pu/Am 11.7
 pCi Am-241 corresponding to 50 pCi total Pu 4.28
 Pu-239/240 7.09E-02
 238/240 Pu/Am 4.41

Location of T-1 with
Proposed Tent Structure

Figure 1-1

EXPLANATION

- 2 Foot Contours
- Groundwater well Locations
- Power poles
- Borehole Locations

Standard Map Features

- F-1 Support Trailers
- Sample Prep Room
- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Paved roads
- Dirt roads

DATA SOURCE: Topographic, hydrology, roads and other features shown on this map were derived from data collected by SRS/RSI, Las Vegas. Digitized from the orthophotograph, 1995



Scale = 1:770
1 inch represents approximately 64 feet



State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site



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April 18, 1998